Aviation Week

Including Space Technology

September 7, 1959

SPECIAL REPORT:

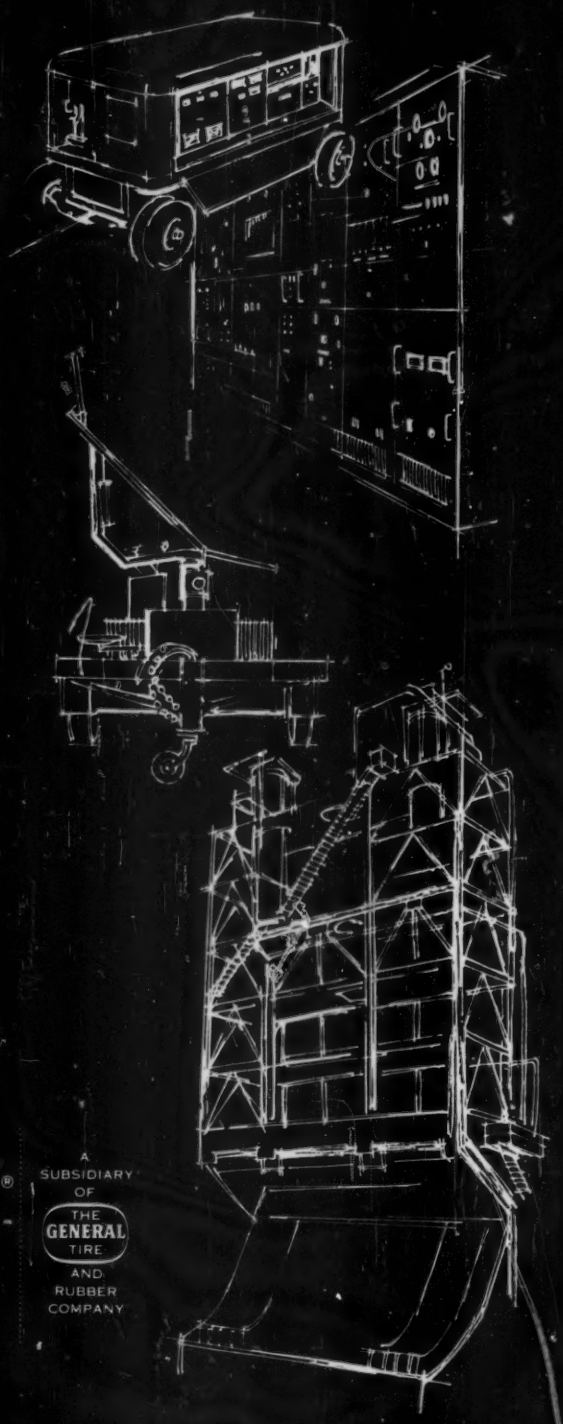
International Astronautical Meeting

United Air Lines Douglas DC-8

GSE by AEROJET

Success in the air depends on support from the ground. Aerojet-General designs and manufactures all types of missile, surveillance drone, and space system ground support equipment.

- General Planning and Logistics
- Test and Launching Facilities
- Ground Handling & Servicing Equipment
- Checkout Systems
- Instrumentation and Control
- Data Systems
- Telemetry
- Communication Systems
- Radar Systems
- Space Position Instrumentation
- Miss Distance Measuring Sets



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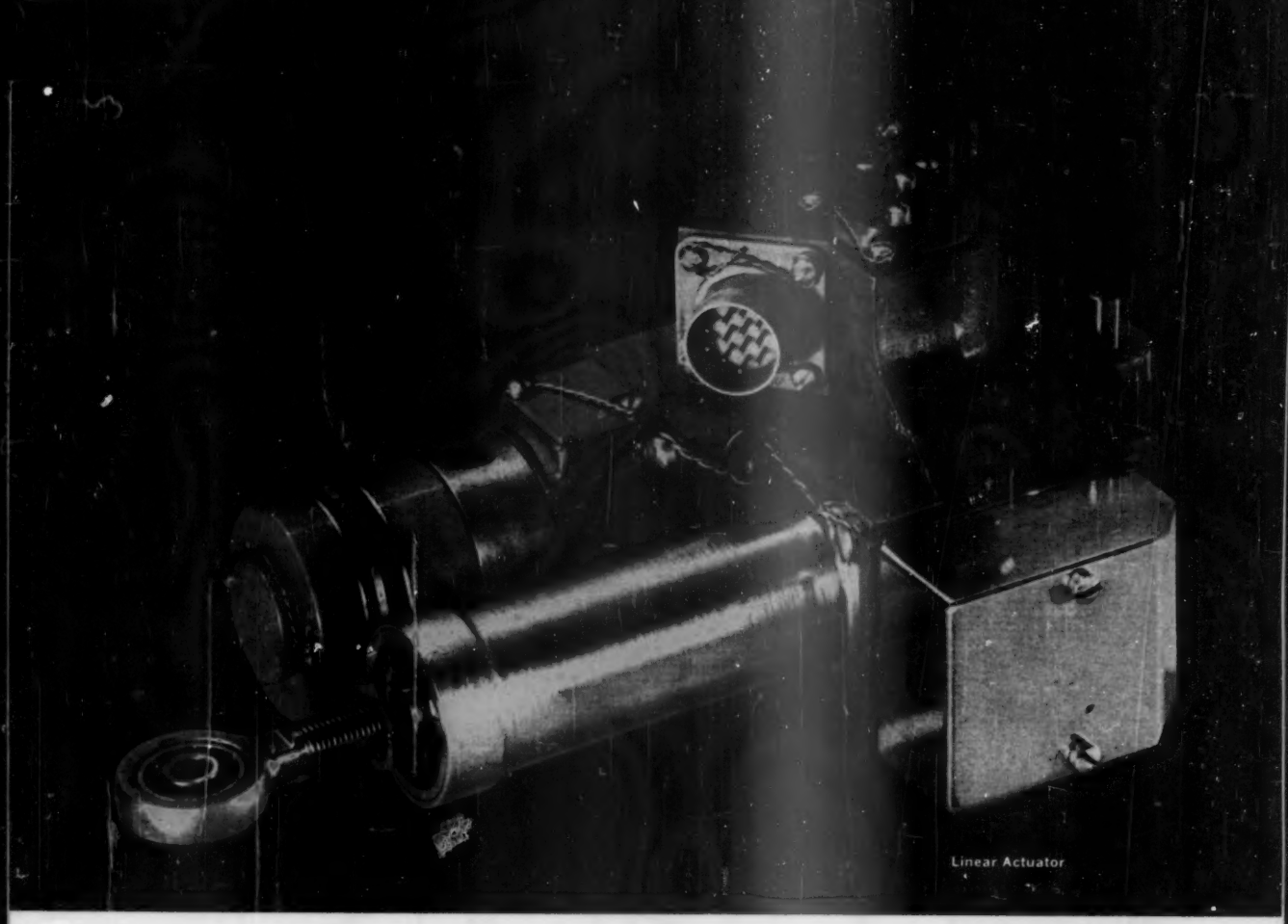
CORPORATION
Azusa, California

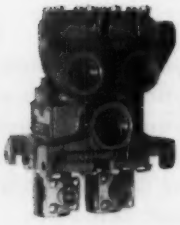
Plants at Azusa, Downey, San Ramon and near Sacramento, California; Frederick, Maryland

Engineers/scientists — investigate outstanding opportunities at Aerojet

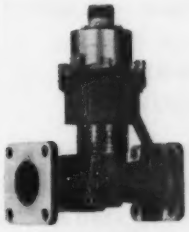


Linear Actuator

A reliable performer in Hydro-Aire's moving story

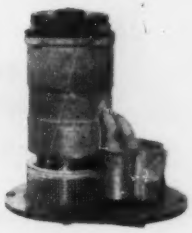


Hydraulic Valve



Pneumatic Operated Gate Valve

High Temperature Regulator and Shutoff Valve



Fuel Booster Pump

Featured above is Hydro-Aire's recent linear actuator design (P/N 20-011) powered by 24 volts D.C. A position-indicating potentiometer transmits ram position signals accurate to ±.001 inches. Actuator travel speed is closely controlled under the range of voltages and loads. Non-jamming mechanical stops limit travel of the ram in the event of switch failure. Write for further details on this and other dependable products illustrated to:

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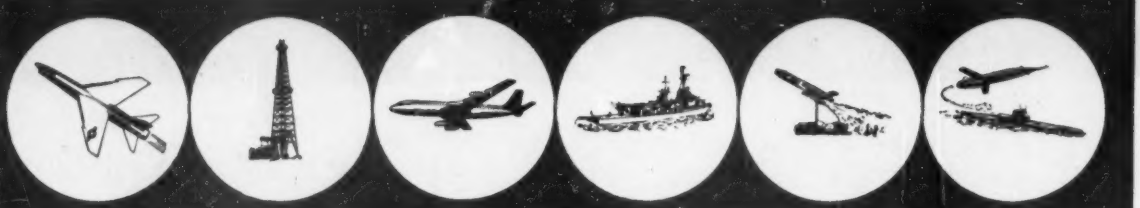

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"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
– U.S. Supreme Court

AVIATION CALENDAR

Sept. 14-15—Display of USAF Ground Support Equipment for Manned and Unmanned Aerospace Vehicles, Society of Automotive Engineers, Milwaukee Arena, Milwaukee, Wis.

Sept. 16-17—Western Regional Meeting on Frontiers of Science and Engineering, Institute of the Aeronautical Sciences, Los Angeles, Calif.

Sept. 17-18—Conference on Effects of Nuclear Radiation on Semiconductors, Western Union Auditorium, New York, N. Y. Sponsor: Army Signal Corps.

Sept. 17-18—Dual National Engineering Communications Symposia, Institute of Radio Engineers' Professional Group on Engineering Writing and Speech, Boston, Mass., and Los Angeles, Calif.

Sept. 19-20—National Air Races (190 cu. in. airplanes), Baer Field, Ft. Wayne, Ind.

Sept. 21-22—Conference on Planning and Designing of Urban Helicopter Facilities, Institute of Aeronautical Sciences Bldg., Los Angeles, Calif. Sponsor: Los Angeles Chamber of Commerce.

Sept. 21-22—Eighth Annual Meeting, Standards Engineering Society, on Investment in Survival, Somerset Hotel, Boston, Mass.

Sept. 21-25—14th Annual Instrument-Automation Conference and Exhibit, Instrument Society of America, Chicago, Ill.

Sept. 23—Second Semi-Annual Area Meeting, Washington Air Route Traffic Control Center, Mariott Motor Hotel, Washington, D. C.

Sept. 23-24—Engine and Operations Symposium, Airwork Corp., Millville, N. J.

Sept. 24-25—Ninth General Assembly, Advisory Group for Aeronautical Research and Development, NATO, Aachen, Germany. Subject: Space Research Techniques and Recent Experimental Data.

Sept. 28-30—1959 National Symposium on Telemetering, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif. Sponsor: Institute of Radio Engineers'

(*Continued on page 6*)

AVIATION WEEK Including Space Technology
September 7, 1959
Vol. 71, No. 10

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HIGH TEMPERATURES and CORROSIVE FLUIDS

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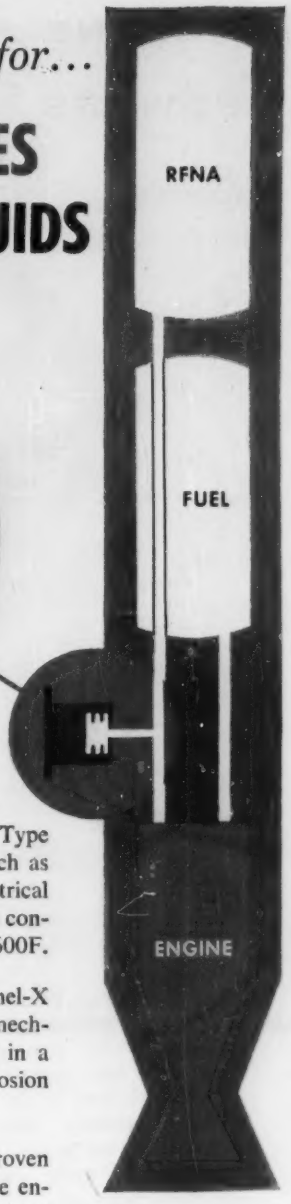
Pressure Potentiometer
shown ¾ size



New Trans-Sonics* Pressure Potentiometers, Type P103, measure pressures of corrosive fluids such as red fuming nitric acid (RFNA) and unsymmetrical dymethylhydrazine (UDMH) for telemetry and control applications at ambient temperatures up to 600F.

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Flexibility of installation is assured by small size and light weight. Dimensions are 1⅞" diameter by 1⅞" long. Weight is only 6 ounces. Standard ranges are 0-100 and 0-150 psia . . . other ranges to special order. Write for Technical Bulletin P103 to Trans-Sonics, Inc., Dept. 7, Burlington, Mass.

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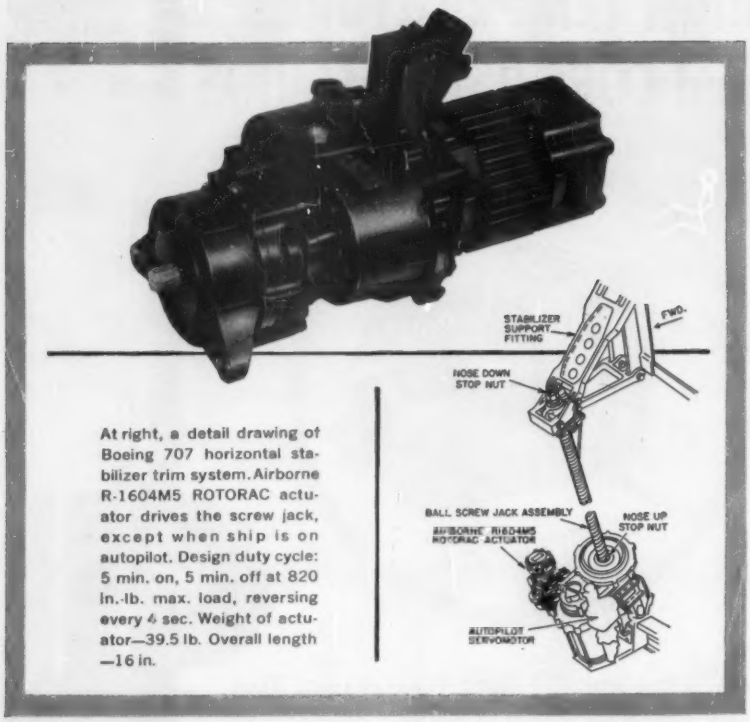

At right, a detail drawing of Boeing 707 horizontal stabilizer trim system. Airborne R-1604M5 ROTORAC actuator drives the screw jack, except when ship is on autopilot. Design duty cycle: 5 min. on, 5 min. off at 820 in.-lb. max. load, reversing every 4 sec. Weight of actuator—39.5 lb. Overall length —16 in.

Because of its function—operation of a primary flight control on Boeing's 707 — this Airborne ROTORAC large special actuator must provide the utmost reliability under almost continuous off-on-reverse type operation. And its response must be quick, even though maximum torque and acceleration are limited by specification — to avoid inadvertent structural overloads.

To control torque, Airborne developed a special friction clutch which limits output to 1500 in.-lb. maximum and yet will transmit 1200 in.-lb. under any condition. Controlled accelerations were achieved by balancing the inertia characteristics of all rotating parts and of the external load against the carefully tailored performances of the motor and servo clutches. Result: smooth acceleration from 0 to 180 rpm in 0.4 second and shock-free reversal in 0.1 second, both at full load.

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AVIATION CALENDAR

(*Continued from page 5*)

Professional Group on Space Electronics & Telemetry.

Sept. 30-Oct. 2—13th Annual Meeting, Southeastern Airport Managers' Assn., Washington Duke Hotel, Durham, N. C.

Oct. 1-3—23rd Annual Convention, International Northwest Aviation Council, Multnomah Hotel, Portland, Ore.

Oct. 5-7—Seventh Anglo-American Aeronautics Conference, Institute of the Aeronautical Sciences, Hotel Astor, New York.

Oct. 5-7—Fifth National Communications Symposium, Hotel Utica, Utica, N. Y. Sponsor: Institute of Radio Engineers' Professional Group on Communications Systems.

Oct. 5-9—National Aeronautic Meeting, Society of Automotive Engineers, the Ambassador, Los Angeles, Calif.

Oct. 6—12th Annual Airport Development & Operations Conference, Hotel Onondaga, Syracuse, N. Y. Sponsor: Bureau of Aviation, New York State Department of Commerce.

Oct. 6-8—12th Annual Meeting, National Business Aircraft Assn., Hotel Leamington, Minneapolis, Minn.

Oct. 6-8—Radio Interference Reduction and Electronic Compatibility Conference, Museum of Science and Industry, Chicago, Ill. Conducted by Armour Research Foundation in cooperation with Institute of Radio Engineers' Professional Group on Radio Frequency Interference. (Classified session on Oct. 8.)

Oct. 6-8—National Airports Conference, Norman, Okla. Sponsors: American Assn. of Airport Executives and the University of Oklahoma; in cooperation with FAA.

Oct. 6-8—Industry-Military Quality Control Management Symposium, Oklahoma City Air Materiel Area, Tinker AFB, Oklahoma City, Okla.

Oct. 6-9—International Symposium on High-Temperature Technology, Asilomar Conference Grounds, Monterey Peninsula, Calif. Sponsor: Stanford Research Institute.

Oct. 7-8—Second Advanced Propulsion Systems Symposium, New England Mutual Hall, Boston, Mass. Sponsors: Air Force Office of Scientific Research; Avco-Everett Research Laboratory.

Oct. 7-9—Sixth National Symposium on Vacuum Technology, American Vacuum Society, Sheraton Hotel, Philadelphia, Pa.

Oct. 7-10—Fourth Annual National Meeting, Air Traffic Control Assn., Biltmore Hotel, Oklahoma City, Okla.

Oct. 8-10—Society of Experimental Test Pilots' Symposium on Pilot's Role in Space Exploration, Beverly Hilton Hotel, Beverly Hills, Calif. Third Annual Awards Banquet, Oct. 10.

Oct. 12-14—15th National Electronics Conference, Hotel Sherman, Chicago, Ill.

Oct. 12-16—15th Annual General Meeting of the International Air Transport Assn., Imperial Hotel, Tokyo, Japan.

Oct. 12-16—NASA's 1959 Inspection, Langley Research Center, Hampton, Va.

Oct. 14-23—"William Tell II" Seventh World-Wide Interceptor Weapons Meet, Tyndall AFB, Panama City, Fla. Host: Air Defense Command.

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MISSILE FOR
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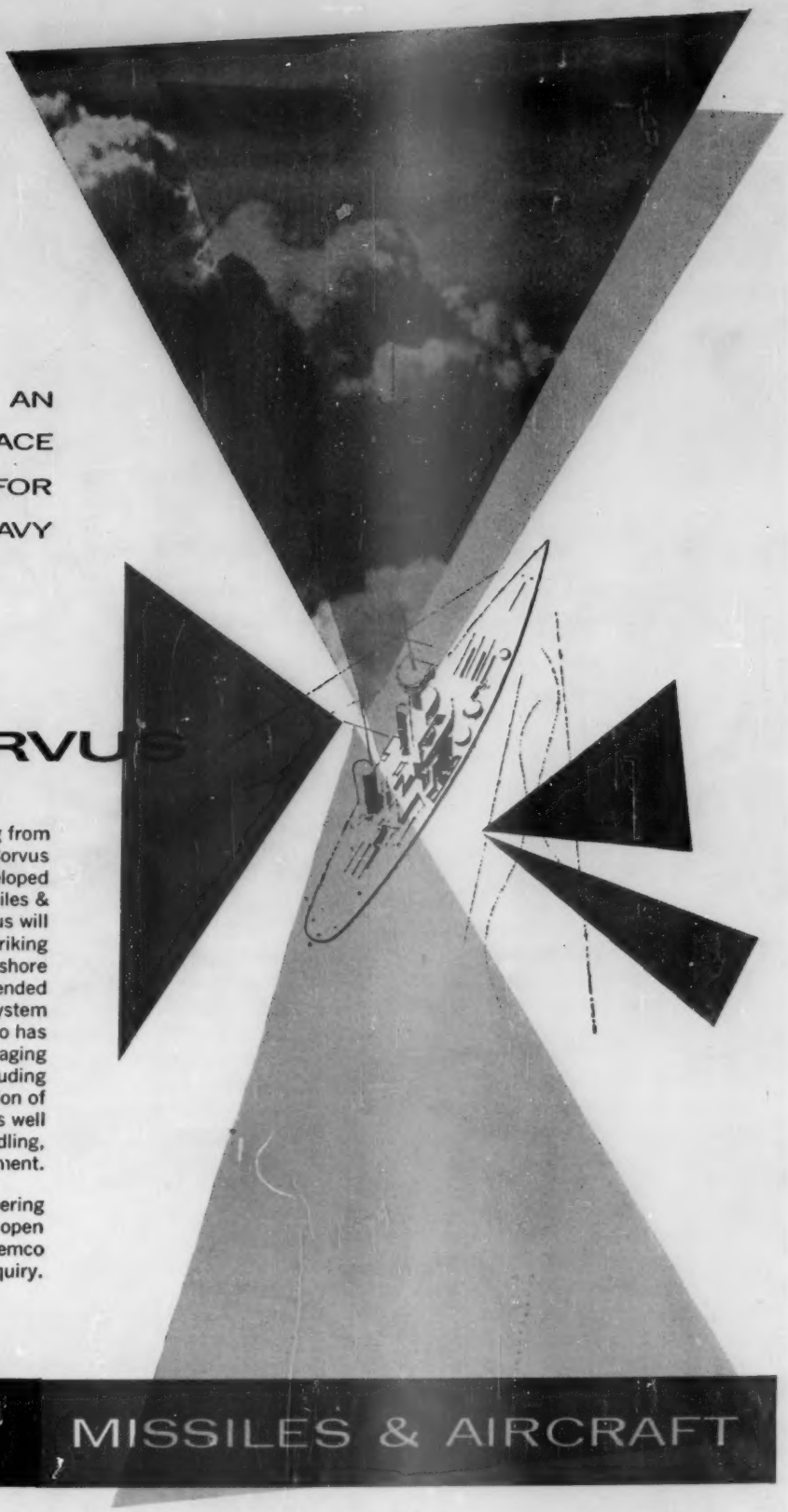

CORVUS

Designed for launching from carrier-based aircraft, the Corvus missile is being developed for the Navy by Temco Missiles & Aircraft Division. Corvus will give the Navy far-reaching striking power — against surface ships, shore installations and heavily defended areas. As weapon system manager for the Corvus, Temco has the responsibility for managing all aspects of the program — including any necessary modification of aircraft for carrying the missile as well as development of ground-handling, test and checkout equipment.

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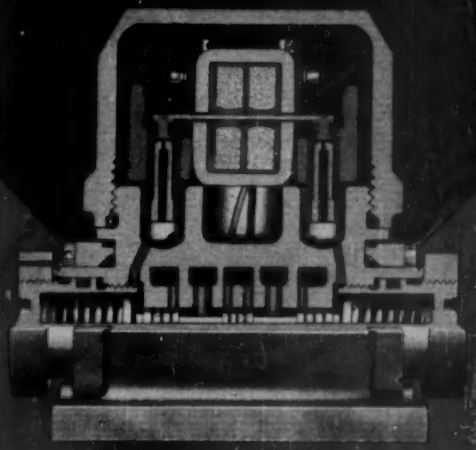

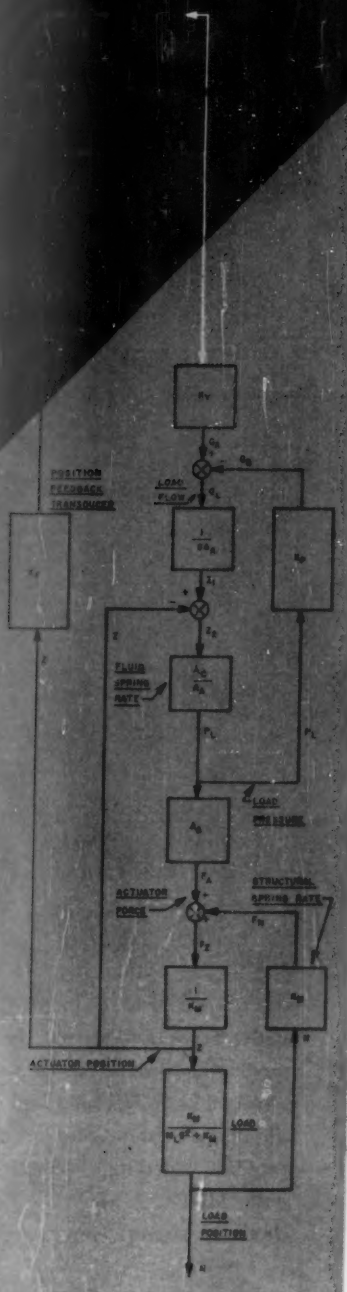

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MOPTAR

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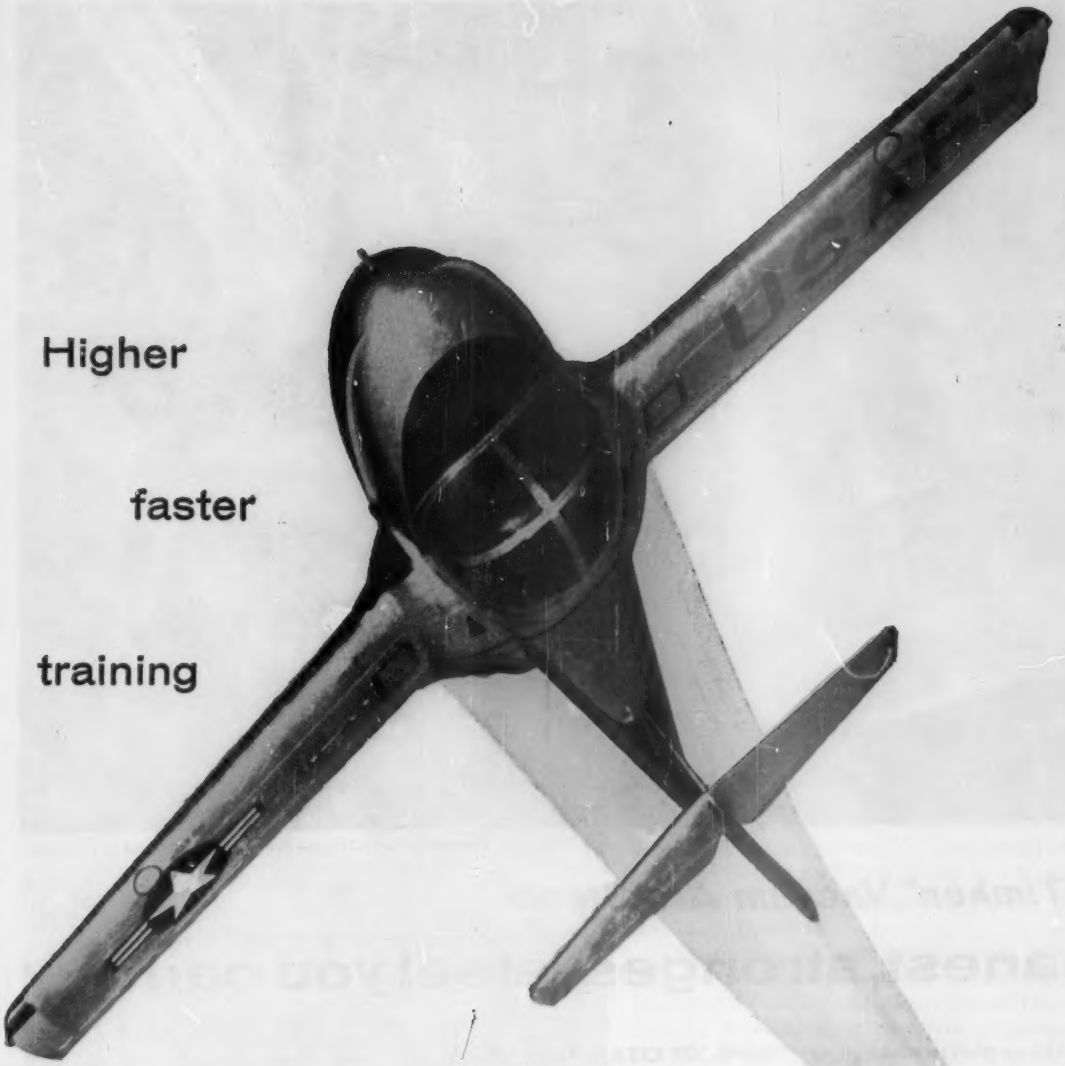

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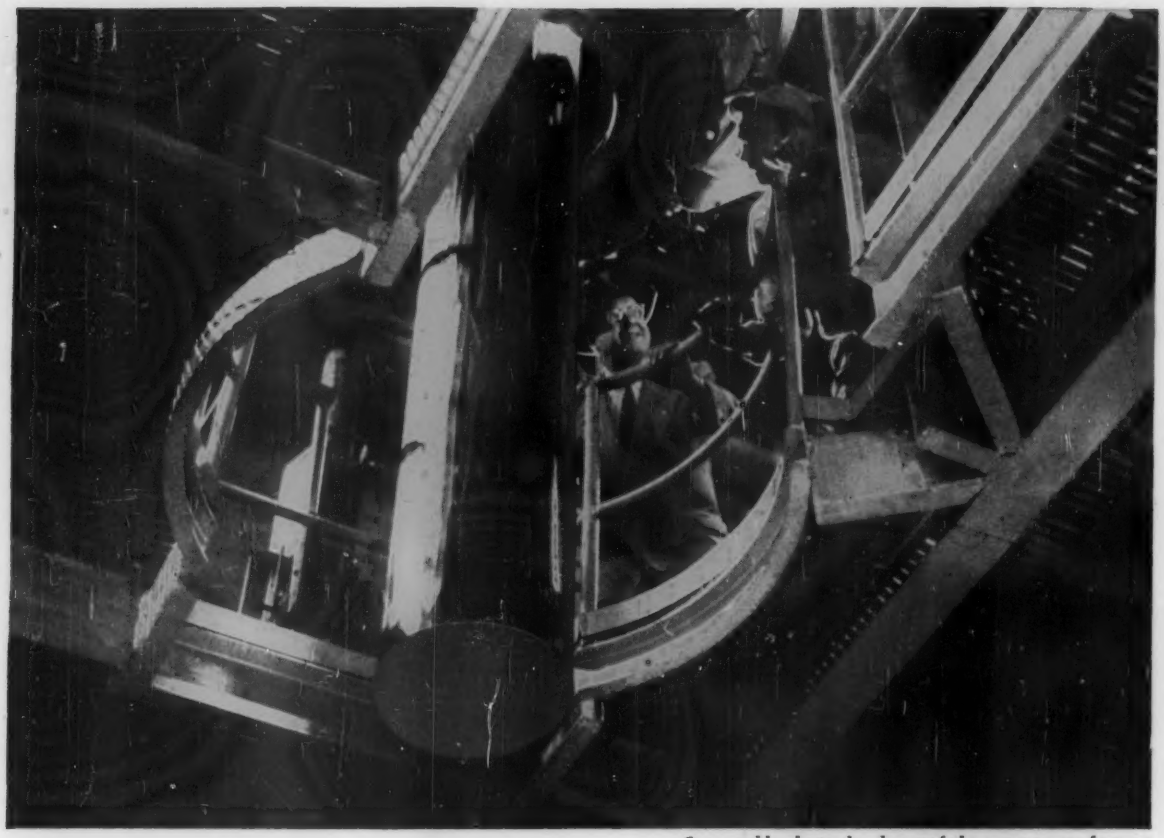
T-37

Cadets in the U. S. Air Force now get a faster introduction to jet flying. Sitting side by side with their instructors, they're quickly learning to handle Cessna's T-37—a new, high-flying trainer with the characteristics of a combat jet. As a result, cadets are trained faster and easier (at substantial savings) to assure America's future in the air. Cessna Aircraft Company, Wichita, Kansas.

Cessna



Consumable electrode—heart of the vacuum arc furnace

New Timken® Vacuum Arc Steel:

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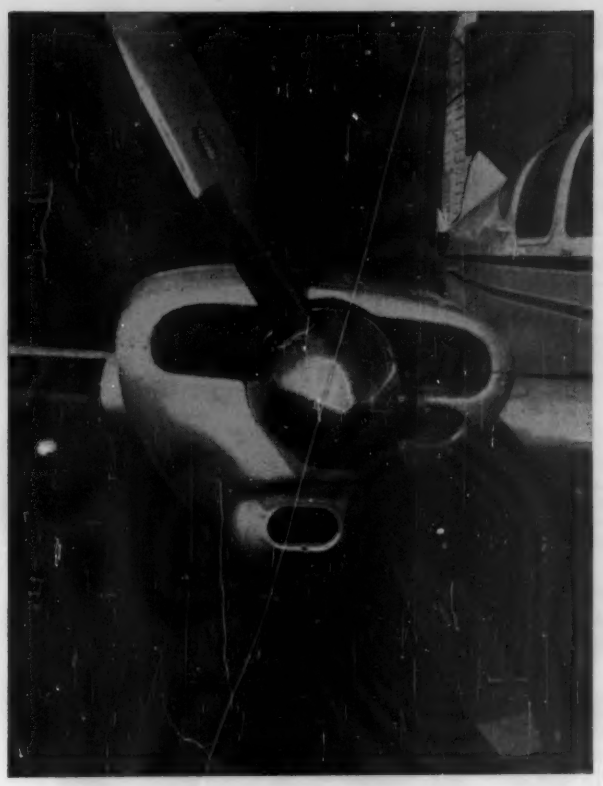
NEW ELECTRICAL PROPELLER DE-ICER FOR LIGHT TWINS



A new B. F. Goodrich Electrical Propeller De-Icer system will soon be available for the Aero Commander, Cessna 310, Piper Apache, and Beechcraft D&E-18, Twin Bonanza and Model 95. FAA certification is now pending.

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BFG Electrical De-Icing eliminates tanks, liquids, valves, motors, etc., required for alcohol de-icing systems. Weight is cut to a minimum—only 8 to 10 pounds, depending on the make and model of aircraft. The system is always ready — no anti-freeze fluid to replenish or run low. Electrical operation and precisely programmed power provide consistent ice protection.

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PV039	.600	10,000	8,000	10.2	4.33	3.46
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▶Close ground cooperation results in near-automatic intercepts from wheels up to flareout on landing.

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EDITORIAL

More Pentagon Censorship..... 21

COVER: United Air Lines Douglas DC-8 jet transport, which enters scheduled service Sept. 18, flies over San Francisco Bay. The aircraft was certificated by Federal Aviation Agency last week. United will use the DC-8 on its New York-San Francisco run; Delta Air Lines will start DC-8 service between New York and Atlanta, also on Sept. 18. For further details, see p. 36.

PICTURE CREDITS

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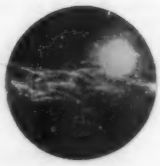
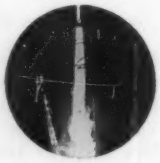
Explorer VI is a space laboratory orbiting around the earth with paddles capturing sunlight for power

The scientific data that will some day enable us to probe successfully to the very fringes of the universe is being recorded and transmitted at this moment by the space laboratory Explorer VI, a satellite now in orbit around the earth ● This project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, will advance man's knowledge of: *The earth and the solar system . . . The magnetic field strengths in space . . . The cosmic ray intensities away from earth . . . and, The micrometeorite density encountered in inter-planetary travel* ● Explorer VI is the most sensitive and unique achievement ever launched into space. The 29" payload, STL designed and instrumented by STL in cooperation with the universities, will remain "vocal" for its anticipated one year life.





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EDITORIAL

More Pentagon Censorship

The attempt to ban publication of the book "Design for Survival" by Gen. Thomas S. Power, chief of Strategic Air Command, adds another chapter to the already infamous record of censorship imposed by politically appointed civilians in the Defense Department.

This censorship campaign of manipulation of military news to present a consistently distorted and overly optimistic view of the defense posture to the American public is directed by the Department's office of public information headed by Murray Snyder. Its activities range from the ridiculous, as covered in our dissertation on "More Monkey Business" (AW July 13, p. 21), to really serious matters such as the suppression of Gen. Power's book. While the secrecy hocus-pocus over use of Indian rhesus monkeys in space research illuminated the timorous ignorance that stimulates some of these alleged security regulations, the case of Gen. Power's book reveals how these security policies are employed to ruthlessly suppress any opinions that might conflict with the present program of drastically weakening our defense forces for purely budgetary considerations.

It also puts a pitiless spotlight of publicity on the vague, shadowy and undemocratic methods of these censors who even extend the cloak of administrative secrecy to themselves in an attempt to conceal their activities from public scrutiny. Rep. Moss (D.-Calif.) and the congressional subcommittee on freedom of information certainly have ample reason to make formal investigation of this case. We await with interest the reply from the Secretary of Defense to the questions raised by Rep. Moss (see p. 34).

The suppression of Gen. Power's book provides a typical case history of how this censorship process now works in the Pentagon. Before writing the book, Gen. Power obtained permission to do so from James Douglas, Secretary of the Air Force, and had the manuscript cleared for military security by Air Force headquarters. The book manuscript was officially transmitted to Murray Snyder's office on April 21, 1959, but, as of this writing, neither Gen. Power nor the Air Force officials who submitted the manuscript through regular channels to the Defense Department have received any official notice of Snyder's refusal to allow the book to be published.

The only communication on the subject emanating from Snyder's shop has been an informal announcement in response to published rumors of the suppression that:

"Approval to publish at this time was denied on the grounds that it was inappropriate for a commander of a major command to author a book concerning his area of responsibility while on active duty in that command."

The flimsiness of this excuse was quickly revealed by a list compiled from official Defense Department sources by Sen. Stuart Symington (D.-Mo.) of more than 15 general officers who have recently written and published books on their areas of military responsibility while on active duty. This list includes President Eisenhower, who published his "Crusade in Europe" while on active duty as the Army's Chief of Staff and who, according to his own figures, profited by over $500,000 through a special tax ruling on his book. In contrast, Gen. Power has proposed that all royalties from his book be devoted to military charities.

Just a few weeks ago, the Defense Department concurred in NASA's decision to allow the seven astronauts (all military officers) to sell their space flight stories exclusively to Life magazine for a sum reported in excess of $500,000. Similarly, the Navy permitted the commander of the Nautilus submarine to write his story in book form while still retaining that command.

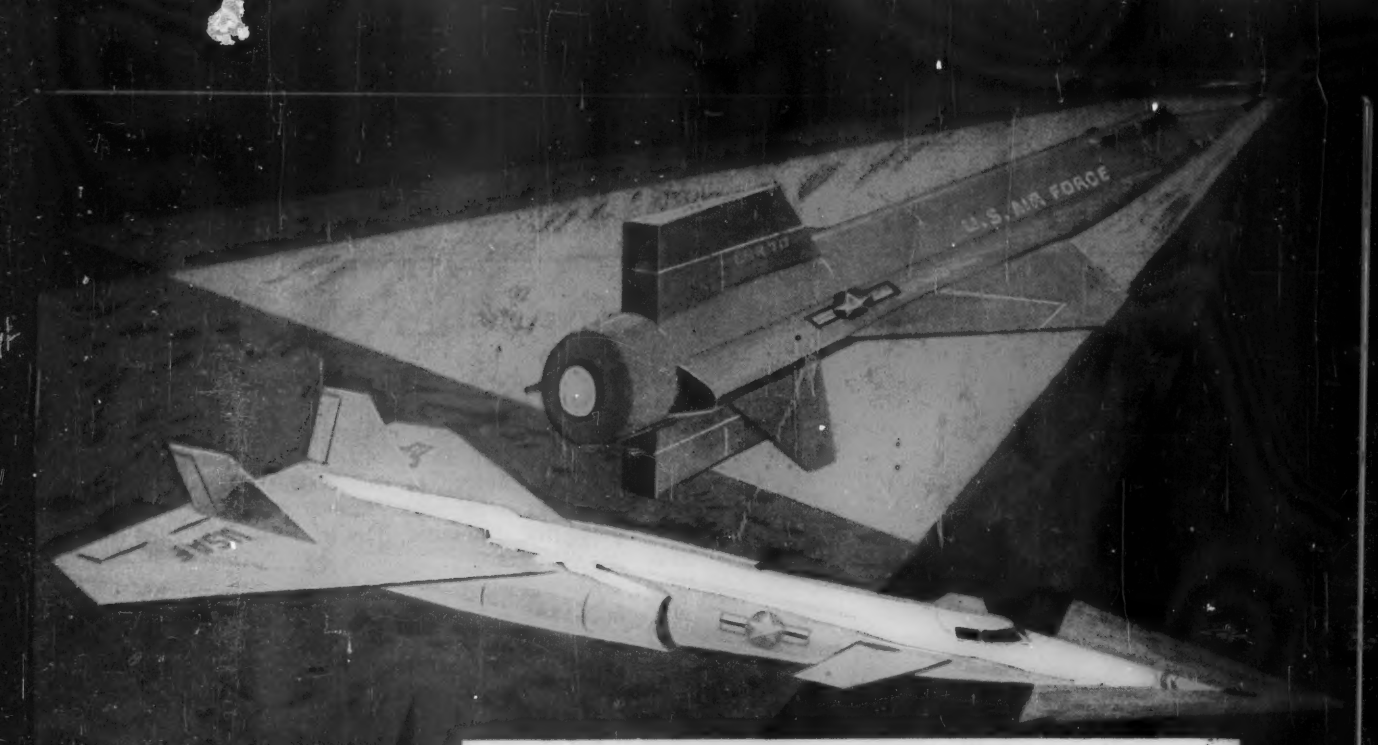
A second flaw in the Snyder statement is that Gen. Power's book, as reported by those who have reviewed the manuscript, is not a book exclusively about Strategic Air Command but rather a much broader discussion of this country's military problems for the future. Few people, military or civilian, in this country are better qualified than Gen. Power to discuss this subject. He has served in strategic airpower in combat and has been one of the principal architects of the strategic deterrent force that forms the keystone of U.S. military policy. He has commanded the vast USAF research and development program in the key era when ballistic missiles appeared on the horizon and today holds the most critical and responsible combat command job in the entire Defense Department.

The real reason Gen. Power's book is being suppressed by the civilian leaders of the Defense Department is that they fear its impact on the program of drastic cuts in U.S. military strength they are planning and will soon announce. These cuts are based solely on fiscal considerations and will slice U.S. military power to the bone in a manner not seen in the Pentagon since the regime of Louis Johnson as Defense Secretary. These cuts and stretches will affect the Atlas ICBM, the B-58 Mach 2 bomber, the B-70 and F-108 Mach 3 generation of aircraft, the hypersonic Dyna-Soar program and even the B-52 and KC-135 production programs.

While these cuts are being plotted in the Pentagon, their advocates are afraid to allow the American people to read the thoughts of the man who is charged with maintaining the strategic deterrent force that they rely on to preserve the peace.

We urge the American people through their press and Congress to bend every effort to smash this medieval chain of censorship that now binds Gen. Power's book and to demand access to his thoughts on an effective design for our country's survival. Whether the American people agree with Gen. Power's ideas or not, it is part of their birthright as citizens of a republic founded on the principles of democracy to have access to them.

—Robert Hotz



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N. Clarkson Earl, Jr., board chairman, Doman Helicopters, Inc., Danbury, Conn., succeeding **Glidden S. Doman,** who will continue as president.

Geophysics Corp. of America, Boston, Mass., has elected the following as directors: **James McCormack,** vice president of Massachusetts Institute of Technology; **James T. Hill, Jr.,** general partner of William A. M. Burden & Co.; **Harper Woodward,** associate of Laurance S. Rockefeller; **Bayard Walker,** vice president and director of Long Island Co., Ltd.; **Vernon Crudge,** aviation consultant.

H. Chapman Rose, acting board chairman, and **Chester A. Thompson,** acting president, Jack & Heintz, Inc., Cleveland, Ohio, succeeding **Frank R. Kohnstamm,** deceased.

R. Carter Dye, president, and **Fred H. Edgar,** executive vice president, Rolle Mfg. Co., Lansdale, Pa., now a subsidiary of DEK Industries, Inc. Also: **William E. Nolan,** vice president and general manager, and **Douglas D. Lawson,** vice president-sales.

David M. Checkley, president, Vitro Engineering Co., New York, N. Y., a division of Vitro Corp. of America.

W. Paul Smith, a vice president, American Bosch Arma Corp., Hempstead, N. Y.

C. Thorpe Thompson, director, vice president and general manager, the Sheffield Corp., Dayton, Ohio, a subsidiary of Bendix Aviation Corp. Also: **W. Fay Aller,** a director and vice president-engineering.

Walter C. Williams, an associate director of the National Aeronautics and Space Administration's Project Mercury, Langley Research Center, Hampton, Va. Mr. Williams will be responsible for launching command, range, data acquisition, and recovery operations. Also: **Charles J. Donlan,** an associate director responsible for the technical development aspects of the project. **Paul F. Bikle** succeeds Mr. Williams as chief of NASA's High-Speed Flight Station, Edwards AFB, Calif.

A. L. Shef, chief of space technology for the Advanced Research Projects Agency, Washington, D. C. Mr. Shef is on leave of absence as chief of the advanced design section in the Douglas Santa Monica missiles and space systems engineering department.

Honors and Elections

Dr. W. Crawford Dunlap, director of semiconductor research for the Research Division of Raytheon Co., has been named editor-in-chief of "Solid State Electronics," a new international publication.

The Franklin Institute has named **David M. Potter,** president of Potter Aeronautical Corp., recipient of an Edward Longstreth Medal. The medal citation reads in part: "In consideration of the increased sensitivity and greater accuracy of an improved type of rotary flow meter (Pottermeter) . . ."

(*Continued on page 103*)

INDUSTRY OBSERVER

► McDonnell F4H all-weather fighter will attempt to break the world altitude record of 94,360 ft. set by Russia in July (AW Aug. 3, p. 32). Navy and McDonnell Aircraft Corp. have Department of Defense approval and are now preparing for the attempt. F4H will have to reach approximately 97,000 ft. to break the Russian record, but observers say the Navy fighter can top 100,000 ft. in a zoom. Defense Department has refused a request by Air Force and Lockheed Aircraft Corp. to make an altitude record attempt.

► **Underwater detonation tests are being conducted by Douglas' El Segundo Division in connection with a Navy contract to develop a detection system for use by small aircraft such as the A4D to use in anti-submarine warfare.**

► Initial Hound Dog production order is for 200 of the North American Aviation air-to-ground missiles, which will be carried by the Boeing B-52G and B-52H.

► **First powered flight of the North American X-15 research aircraft will be limited to a speed of Mach 2 (1,325 mph.) and an altitude of 50,000 ft. As the flight program develops at Edwards AFB, Calif., the X-15 may exceed Mach 6 (approximately 4,000 mph.) and 100 mi. in altitude.**

► Air Force is developing a General Operational Requirement for a turbine cargo transport to replace the Douglas C-124. Powered by turbofan engines, the transport would be smaller and have shorter range than the DC-8 and 707, but its fuselage would have a bigger cross section to provide greater capacity.

► **Nearly all major airframe, engine and avionic manufacturers have constructed or are planning facilities for the study of magnetohydrodynamics, indicating that future competition will be intense for contracts to build ion and plasma engines. Study and test facilities for this work are inexpensive by current standards.**

► Use of guided microwaves to accelerate plasma for satellite orientation and other very low thrust requirements is being studied by the National Aeronautics and Space Administration.

► **In line with the over-all reinforcement program for the Japan Air Self Defense Force, Japan's Air Staff Office is considering adoption of turbine-powered helicopters to go into service after Fiscal 1961. Among helicopters under study are the Sikorsky S-61, S-62, S-63, Bell HU-1A and Vertol V-107.**

► East German design team headed by Brunolf Baade is developing a twin-jet transport for short and medium range operations that will be slower but more economical than the four-jet Baade-152 developed by the same team. New transport will be designed to operate from grass fields.

► **Low residue diet for National Aeronautics and Space Administration's Mercury space pilots is expected to eliminate the need for a solid waste disposal system, although the pilots also may have drugs aboard to curb waste elimination. Pressure suit will have provisions for moving urine, storing it in the suit and moving it out of the suit for storage and examination after landing.**

► Sikorsky HSS-2 No. 2 has been extensively damaged during a preflight check of control servos at high rpm. Servo failure caused the machine to nose over, striking the rotors on the ground. It then fell back on the tail rotor, Subsequent damage included a small fire started by a ruptured fuel line. Impact damage made the helicopter virtually a total loss, but the loss is not expected to delay the Navy program since at least two other HSS-2s are now flying.

► **Avco Corp. Research and Advanced Development Division has a $36,655,000 contract to develop a nose cone for the Minuteman ICBM. Contract includes ablation studies and development of ablative material for the re-entry vehicle. Avco also is developing the Titan nose cone, and similarities between the two re-entry vehicles is expected to permit joint research and design in some areas.**

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Washington Roundup

USAF Missile Management

Members of Congress are predicting that General Accounting Office's coming report on Air Force management of its ballistic missile programs will reveal widespread cases of mismanagement and overcharges to the government. The report is scheduled for submission to Congress when the new session convenes in January. GAO undertook the investigation because USAF declined to make available to it the full report of an investigation by the USAF Inspector General (AW Nov. 17, p. 34).

House Government Operations Committee commented in a report last week:

"Judging from the rather frequent reports of excess payments made by the government on contracts in less urgent military programs, the ballistic missile area undoubtedly will turn up many cases of this kind. When urgency is great . . . costs are of lesser concern."

New ARPA Projects

House Government Operations Committee disclosed last week that these new projects have been assigned to Advanced Research Projects Agency:

- **Tribe, a continuing family** of advanced military space vehicles capable of satisfying designated military space missions, including guidance, stabilization, and control components.
- **Suzano, a space platform** to provide an orbital base for advanced space missions.
- **Principia, involving solid propellants** with higher specific impulses than now under development.
- **Pontus, a major improvement** in structural and power conversion materials to satisfy certain missile and other programs.
- **Longsight, continuous studies** and systems analyses in the space vehicle and missile fields to provide the basis for recommendations on projects to satisfy future military requirements.

Anast Joins FAA

Top post in the Federal Aviation Agency's Bureau of Research and Development was filled last week with the appointment of James L. Anast, former technical director of the Airways Modernization Board. This leaves only top positions in the agency's Bureau of Facilities and Office of Public Affairs as the major slots in the agency's organizational structure yet to be filled. Indications are now strong that the latter position will go to Jack Gertz, presently associated with the Mutual Broadcasting Company's public affairs office here.

Anast left the Airways Modernization Board last year to join Lear, Inc. He later was named president, a position he held for a brief time prior to his return to government service.

Delta Pilot Protest Rejected

Reluctance to become involved in labor-management disputes was a major reason cited by the Civil Aeronautics Board last week in rejecting the protest of a group of Delta Air Lines pilots against the seniority listing used since the airline merged with Chicago and Southern Airlines in 1953. Declaring that the petitioners had failed to charge either Delta or the Air Line Pilots Assn. local chapter with acting in bad faith in drawing up the seniority list which has been in effect for nearly nine years, the Board said it dismissed the petition for lack of evidence. CAB said it has always followed the policy of expecting the remaining company in any merger to carry out seniority integration in an equitable manner.

Translation Research

Continued research in the use of high-speed electronic computers for translation of foreign language scientific articles was urged in a House Science and Astronautics Committee report. The report said it is doubtful that fully automatic, high-quality machine translation can ever be attained, but the machines can certainly be used in the future to reduce the human work load greatly.

Equal Wage Bid Lost

Aircraft industry has lost an important round in its campaign to equalize avionics industry Walsh-Healey minimum wages with its own. Walsh-Healey Act requires Labor Department to survey an industry to determine the prevailing minimum wage, and that prevailing wage is set as the minimum in government contracts. Aircraft industry wanted aircraft and missile electronics companies included in the aircraft classification so they would have to pay the same minimum wage, arguing that it is unfair to allow the electronics firms to compete with a lower minimum wage. Labor Department refused to include them.

Some new companies may be included in the aircraft industry category under a new study Labor Department will conduct to determine whether the present definition should be expanded to include certain phases of missile production. These phases include nose cones, propulsion systems and assembly and structures, but manufacturers of electronic equipment for aircraft and missiles are specifically excluded. Labor Department said data compiled by the Defense Department on major companies making electronic gear for aircraft leads to the conclusion that they should be excluded from the survey of aircraft and missile plants.

Some change in the Walsh-Healey minimum wage gap between the aircraft and electronics industries could rest from a survey of the electronics industry the Labor Department will conduct later. This survey, which will include manufacturers of aircraft and missile electronic equipment, will determine whether a new minimum should be set for the industry.

New Express Pact

Agreement on a new contract between the scheduled airlines and Railway Express Agency covering air express activities was expected by the end of last week. The new contract, which will replace a contract that expired July 31, will run for five years and will establish a regular working partnership between the carriers and the agency for the first time. In the past, the agency has conducted its pickup and delivery service on a cost-plus basis. Under the terms of the new contract, the two groups will share in revenues after deduction of expenses. In addition, a joint committee, comprised of airline and agency representatives, will be organized to handle all operating problems, including air carrier scheduling and truck pickup times.

—Washington staff

Dryden Foresees World Cooperation on

Space research needs world's ideas, NASA deputy administrator tells Astronautical Congress.

By Evert Clark

London—There is "every indication that space exploration may soon develop beyond the resources of a single nation" to carry it out, demanding an unprecedented degree of international cooperation, Dr. Hugh L. Dryden, deputy administrator of National Aeronautics and Space Administration, told the 10th International Astronautical Congress last week.

"Space research needs to draw upon a whole world for its ideas," Dr. Dryden said. "So vast is the challenge and so vast is the promise to mankind that the world cannot afford to neglect it."

Recognition that even more international cooperation is rapidly becoming an essential of space flight, and not just a desirable supplement, dominated the Congress, attended by some 700 delegates from more than 30 nations.

Dr. Dryden delivered the inaugural speech.

Both the Congress, sponsored by the International Astronautical Federation, and the first Commonwealth Spaceflight Symposium which preceded it, were marked by a strong feeling that the United Kingdom no longer can afford to be just an observer of the space race between the United States and the Soviet Union.

General attitude in Britain previously has been that the great head start and greater financial resources of both larger countries left Britain hopelessly behind, and that perhaps Britain should not be involved in such a race, anyway.

But a feeling that the United Kingdom must advance in space exploration if it is to maintain its position politically and scientifically apparently is crystallizing rapidly with the recently concluded U.S.-U.K. satellite launching agreement behind and the availability of the Saunders-Roe Black Knight and de Havilland Blue Streak rockets not too far in the future.

Dr. R. N. Quirk, secretary in the Lord President's office, said the United Kingdom is "tremendously indebted" to the U.S. for this cooperation and said it is "quite extraordinarily moving" that "such enlightening people as Dr. Dryden" in the U.S. government had made such a contribution.

To increase such cooperation, IAF President Andrew G. Haley proposed not only a permanent secretariat for the IAF but also an International Academy of Astronautics. Ideas on such an academy vary widely among the delegates and by late last week there was more agreement that such an organization should be created than there was on how it should be constituted.

The joint program calls for the U.S. to launch three British scientific satellites, 20 in. in diameter and 20 in. long and weighing about 150 lb., by mid-1961, using the four-stage Scout solid rocket now being developed by the U.S. (see p. 64). Payload work will be handled by 10 British teams and experiments will investigate several important physical characteristics in space at about 300 mi. altitude.

One estimate is that the program will last about four years and cost about $2.8 million.

Both de Havilland and Saunders-Roe have design studies calling for the launching of satellites and probes using combinations and modifications of Blue Streak, which is to be a 1,500-mi. ballistic missile powered by a Rolls-Royce version of the Rocketdyne Thor engine: and Black Knight, a research rocket which has just appeared in a new configuration with a solid stage added to give it the ability to push payloads to satellite velocity.

G. K. C. Pardoe, chief coordinator of ballistic missiles for de Havilland Propellers, Ltd., proposed several missions for these combinations of the two rockets in a report to the Commonwealth Symposium. His proposed follow-up report for the IAF Congress, titled "The Potentiality of Blue Streak in a British Space Flight Program," was withdrawn for security reasons.

Pardoe's suggestions for space vehicles included:

- **Blue Streak plus a dual** solid propellant engine now under development to put some 1,000 lb. in a 300-mi. circular earth orbit.
- **Blue Streak plus Black Knight,** which has a four-chamber, 16,000-lb. thrust Armstrong-Siddeley engine, to carry 1,000 lb. of payload. Black Knight, which has been fired at least four times, "is demonstrating a remarkably high state of reliability," Pardoe said.
- **Blue Streak** plus the Black Knight engine, but with tankage enlarged and modified into a "doughnut" configuration to give the upper stage the same maximum diameter as the first stage and to avoid problems presented by a long, thin second stage. This could double the payload capacity over the

British Seek Active Space Role

London—Britain's desire to play a far more active role in the exploration of space is expected to receive the much needed boost of stronger government support if the present government is returned to office in general elections expected next month.

Spurred by strong industry participation in the first Commonwealth Spaceflight Symposium, and the 10th International Astronautical Congress here last week, the government is believed to be ready at last to begin making Britain a space power, once the elections are out of the way.

Because tax cuts are far more popular with the British voter than spaceflight, government support of an enlarged space program is not being discussed as an election issue. But private talks between advocates of a stronger program and government officials have left the advocates with the definite impression Britain no longer feels it can afford not to develop its space capabilities.

Minister of Supply Aubrey Jones, whose agency would direct most of the government's participation in a space program, officially opened the Astronautical Congress.

"Many in Galileo's generation scoffed at his telescope," Jones said. "We should be chary in our own generation and in relation to the satellite of repeating that inglorious episode of history. In short, it is much easier for modern states to decide that space research is worthy of their support than it was for the Grand Duke of Florence to decide whether or not Galileo should not be supported.

"What the total resources are out of which this support can be given, what the diversion from these resources is to non-scientific purposes—to discuss these would be to admit you into the arcana of politics, and before this audience I think I should remain on strictly scientific terrain.

"Scientifically, there is surely no doubt at all but that every state which claims to bear the banner of civilization should do everything it can to encourage advances in the knowledge of the physics, chemistry and even the biology of space."

Space Efforts

previous vehicle, putting 2,000 lb. into a 300-mi. orbit.

• **Addition of a simple single** solid stage on top of the doughnut tankage to put a smaller payload deeper into space.

All proposals depend only on equipment already in existence or being developed here, and obvious improvements could be made if special stages were developed or higher energy fuels used.

John E. Allen, head of Aerodynamics, Projects and Assessment Department of A. V. Roe and Co., Ltd., proposed similar combinations in a thorough survey of British scientific organizations and research facilities. He advised against an expensive space program for the moment but recommended a "pilot experiment" approach to spaceflight, including creation of a spaceflight research association, relatively inexpensive hypersonic flight experiments, etc., for the present; and creation of an earth satellite experimental laboratory for physical, astronautical and medical work and development of a hypersonic long range aircraft for the future that would be able to launch satellites.

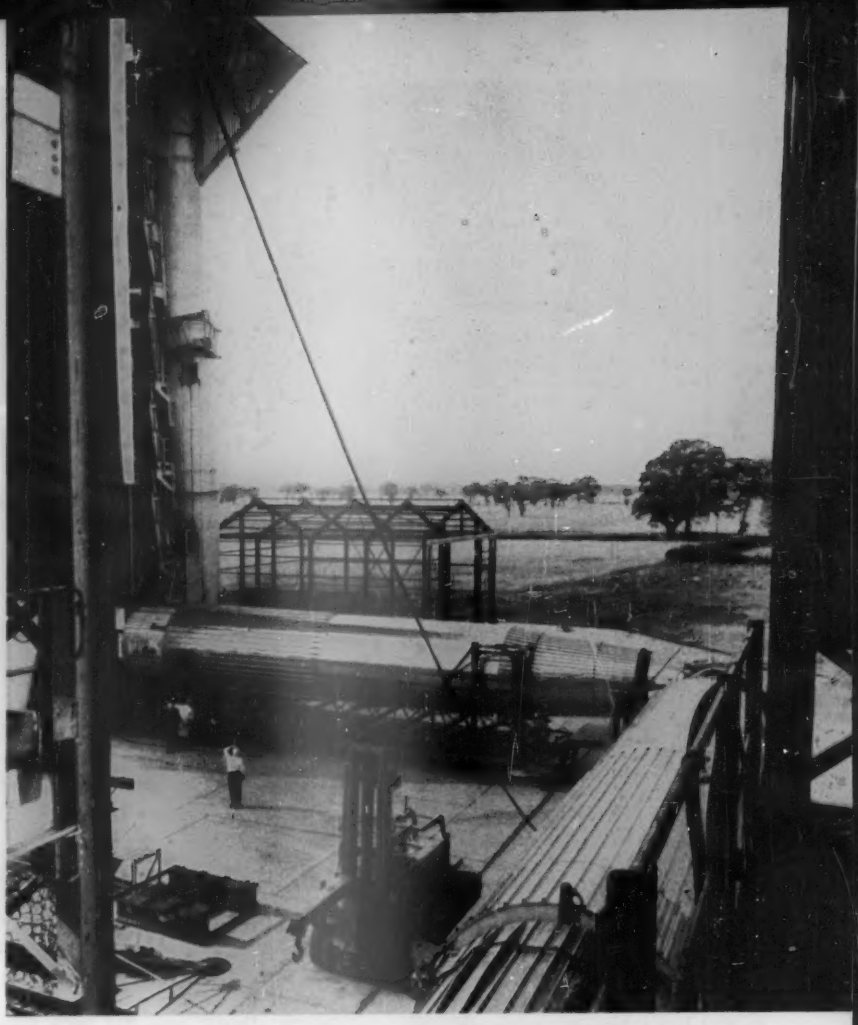
Test Shape

Allen also proposed development of a high drag, high lift re-entry test shape to be launched by a Douglas Thor booster for flight to about Mach 20: and a Mach 15 cruise shape for controlled re-entry, skip or long range ramjet transport, to be air-launched from an Avro Vulcan by a two-stage solid rocket.

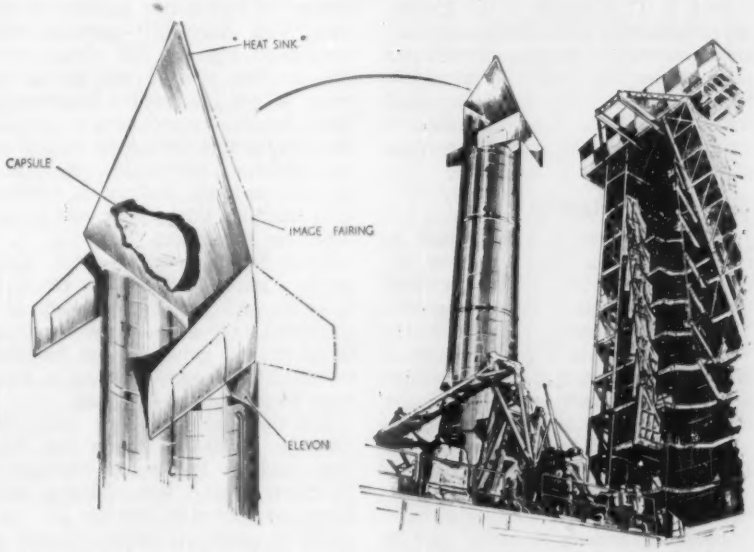
Dr. W. F. Hilton of Hawker Siddeley Aviation's Advanced Projects Group described a wedge-shaped, high lift, high drag "flying pyramid" that could be used as a two-man earth satellite. Hilton believes that some type of high lift, high drag shape will be used for all manned space flight requiring earth re-entry beyond the first steps, and that the high drag shape such as the U. S. Mercury capsule will quickly be abandoned. Models of the pyramid have been catapulted into free flight and tested in wind tunnels at Armstrong Whitworth Aircraft, Ltd.

Soviet delegation caused a minor stir when one member, Prof. V. I. Krassovsky, was quoted in a London newspaper as saying that the U. S. carried out nuclear tests in the upper atmosphere after the beginning of cessation of atomic tests last fall.

At a press conference later, Prof. Leonid Sedov, chairman of the USSR Academy of Sciences Space Flight Commission, said that Krassovsky had been misunderstood, and that what Krassovsky had said was that lithium content in the upper atmosphere was high



BRITISH Blue Streak missile, designed by a team headed by de Havilland Propellers, Ltd., is readied for erection in a test tower at Hatfield, England. Missile will be fired from underground launch sites, will have nuclear warhead. Trials will be at Woomera, Australia.



WEDGE-SHAPED, high lift, high drag "flying pyramid" model has been tested in Armstrong-Whitworth wind tunnel. Configuration was described by Dr. W. F. Hilton, of Hawker-Siddeley (which controls Armstrong-Whitworth); note capsule for two space aeronauts.

last January and must therefore have been considerably higher immediately after the bomb tests. Third Soviet delegate was Prof. Kyril Ogorodnikov, astronomer, of Leningrad.

Sedov was asked about another newspaper statement attributed to the delegation to the effect that Russia might try to put a man in orbit within two years.

"This conversation was in the form of a joke and the correspondent took it as a reality," Sedov said.

He also said Russia has not yet fired a man along a ballistic trajectory. Some U.S. observers believe Russia tried this last May 1 and lost one of their space pilot trainees when the launching rocket exploded on the pad. Soviets have said they lost one of four trainees in "an accident," (AW June 22, p. 79).

Pioneer IV Comment

Sedov said it was his personal opinion that the U.S. solar satellite Pioneer IV was a "great achievement" both in rocketry and in research, but he refused to compare U.S. and Soviet rockets on the grounds that this went beyond the limits of a technical discussion. Asked if the West could expect details of Soviet satellite launchers since the U.S. had provided launcher information, Sedov said details are always published along with announcements of satellite launchings.

Soviet space flight goals include "new Sputniks, space flights in the region of and on the moon and interplanetary flights," he said. He refused to give timetables, suggesting that the delegates "read the papers." Asked when announcement of another achievement could be expected, he said: "anytime."

Prof. S. Fred Singer of the University of Maryland, who at last year's Congress proposed a sweeper satellite for cleaning out the radiation belt (AW Sept. 1, 1958, p. 21), this year reversed his field. Now he wants to create an artificial belt of radiation for study of the earth's atmosphere.

Electron Accelerator

Singer suggested using a satellite or rocket to carry a 500-lb. electron accelerator to an orbital altitude between 600 and 1,000 mi. near the equator. The accelerator would be operable for about 100 sec. and would inject a stream of electrons of about two million electron volts (mev) energy into the upper atmosphere. These would develop rapidly and tend to stay trapped in the earth's magnetic field. Losses would occur primarily through collisions with the very rarefied atmosphere.

Sounding rockets could be used to study the remaining number of electrons on a daily basis, and the data from the firings would produce an electron density profile. This could be related to atmospheric density at the altitude of the belt.

Sweeper theory now has been substantiated by available data, Singer added, and the scheme is still interesting in theory, if not necessarily in practice. Reason is that the actual number of high-energy particles in the lower Van Allen belt—particles with energies as high as 700 mev—is very low, on the order of one particle in every 10 million cubic centimeters. Space travelers would have to stay in the belt for about one hour to pick up the maximum permissible yearly dosage in roentgens, and unless orbiting in a satellite, they would not be exposed for this time.

Four Soviet scientists—Prof. Krassovsky, Prof. I. S. Shklovsky, Dr. G. I. Galperin and Dr. E. M. Svetlitsky—presented some data on the upper atmosphere and specifically on the outer radiation belt, complementing in some ways Singer's preceding report.

For the first time, they said, soft electrons of 10 kev energy had been discovered in the upper atmosphere by Sputnik III. Soft electrons were found at altitudes between 291 and 1,167 mi., with minimum intensity at about 800 mi. above the geomagnetic equator.

Milton W. Rosen and F. C. Schwenk of National Aeronautics and Space Administration, presented a discussion of the NASA's Nova space vehicle which had a configuration slightly different than that shown in previous artist's conceptions but did not differ from previous discussions in over-all concept or in the key design factor that the vehicle depends on the 1.5-million lb. single chamber Rocketdyne liquid fuel engine now under development (AW June 1, p. 30).

Their vehicle would carry two or three men, would be 220 ft. long, have a takeoff thrust of more than 6 million lb. in the first stage, and would return a weight of 8,000 to 9,000 lb. from the moon by using five stages.

A low-cost, three-stage solid propellant space vehicle called Envoy was proposed by H. L. Thackwell, Jr., senior vice president of Grand Central Rocket Co. He said it would send 50 lb. to the moon or place a 230-lb. payload into a 300 mi. orbit at a cost of "considerably less than the $500,000 figure for the Scout or the $1-million for a single Thor liquid booster." Envoy would weigh only 17,000 lb. and stand 37.8 ft. high. Two-stage Envoy could put 60 lb. in a 300-mi. orbit or boost five pounds to escape velocity. Used as an air-launched satellite vehicle, Envoy could put 430 lb. into a 300-mi. orbit, he said.

Soviet Space Safety

London—Adverse propaganda effect of reports that Soviet Russia may take greater risks in manned space flight because it has less regard for human life than the Western world apparently is causing great concern to Soviet space scientists.

A three-man delegation to the 10th International Astronautical Congress here last week emphasized the importance of "safe cosmic flight" and said it is the main problem to be solved before a man is put into orbit.

Recent visitors to the Soviet Union who have talked with space scientists there say the Soviets frequently brought up the subject of safety themselves in an apparent attempt to counter the impression that their first space pilots will face greater risks than U.S. space pilots.

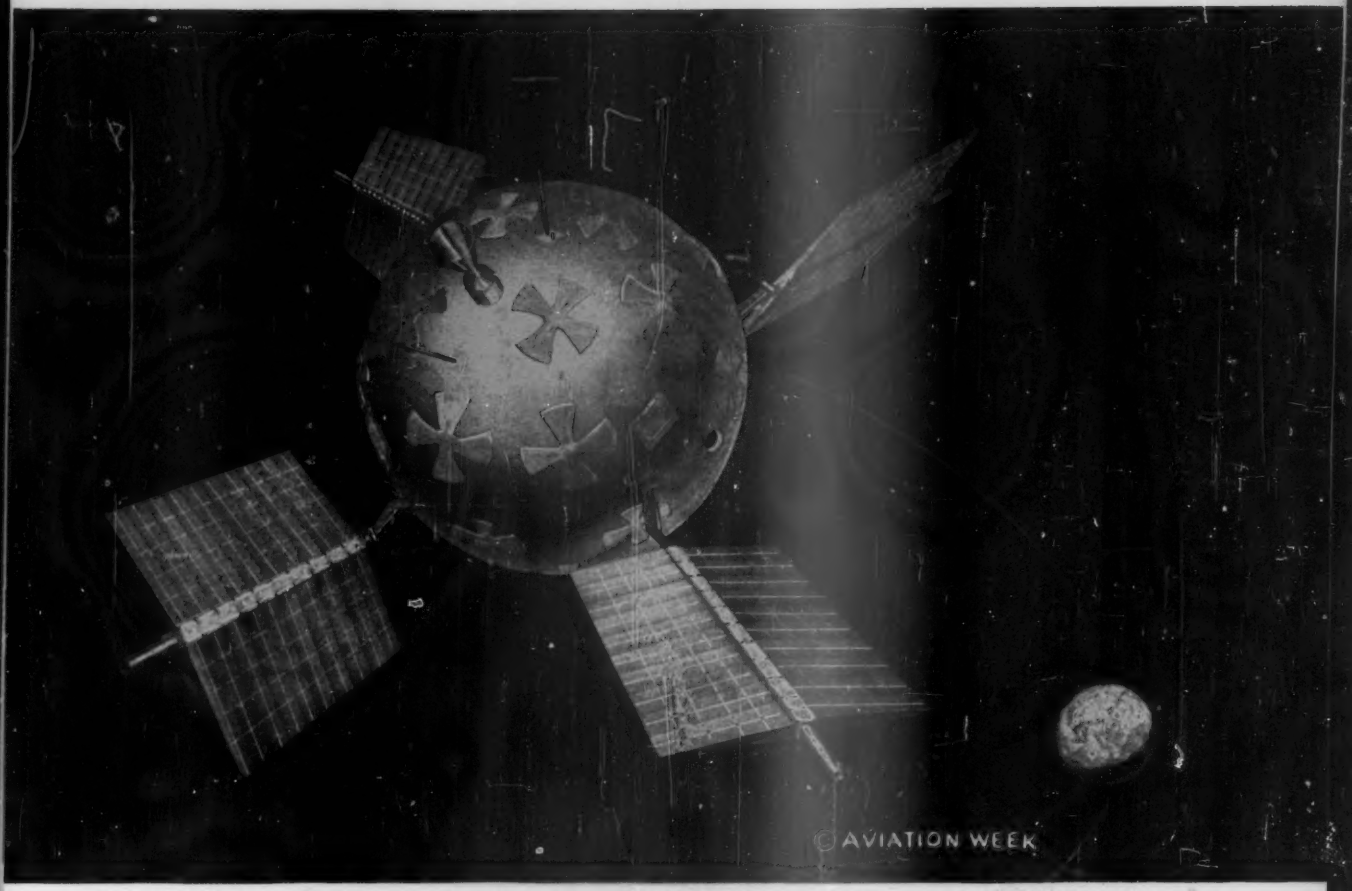
This emphasis on safety has led some U.S. observers to speculate that Russia will not attempt to put a man into orbit until it can launch a two-man capsule, so that even if one pilot should die, it can be pointed out that every precaution was taken, even to sending a companion with him for safety purposes. Since Russia already is known to have the booster power to launch a two-man capsule, one estimate is that the two-man flight might take place sometime next summer.

Company Formed To Test Swiss P.16

Geneva—Flight testing of Swiss-built P.16 ground support fighters will be done by Aktiengesellschaft fuer Flugzeugunternehmungen, Altenrhein, a new company specially formed to relieve the P.16's manufacturers, Flug & Fahrzeugwerke Aktiengesellschaft, Altenrhein, of this responsibility.

Later on, the new company probably also will market this airplane. Activities of the new firm are registered as manufacture, sales, development, testing, repair, inspection and maintenance of aircraft and aircraft components. Company capital is 500,000 Swiss francs, or about $100,000.

Dr. Josef Riedener has been appointed director and Dr. Hans Studer, chief engineer. After the crash of the third P.16 prototype last year (AW June 9, p. 25) Swiss order for 100 P.16s as the second stage in Swiss Flugwaffe's re-equipment program was canceled in June, 1958, only about three months after the order was placed by a majority vote in Swiss parliament (AW Mar. 24, p. 65) and was substituted by an order for 100 Hawker Hunters. At present, Flug & Fahrzeugwerke has two completed P.16s and another one is nearing completion and will fly later this year.



ARTIST'S SKETCH shows how lunar satellite will have "propeller blade" units spotted on its surface to control internal heat.

Space Technology

'Propeller Blades' Control Able IV Heat

Satellite to be put into orbit around the moon by Atlas Able IV space vehicle scheduled for an Oct. 3 firing from Cape Canaveral, Fla., will include a new, stubby heat-reflecting "propeller blade," or pinwheel-shaped mechanism for precise temperature control within the orbiting sphere. The devices will be spotted over the satellite shell.

The satellite will scan the lunar surface through a hole (lower right on sphere) with a facsimile system similar to a television camera. Square, window-like units are heat sink installations, probably to dissipate heat from within the sphere. An injection rocket, with its nozzle protruding from the sphere, will give the satellite added boost, as required. Antennas protrude near each side of the rocket nozzle.

Instrumentation's Function

Functioning of the tightly packed instrumentation and batteries in the satellite, used in collecting and telemetering to earth the extensive information on space conditions and lunar environment, will depend on maintaining an adequate heat level in interior compartments., Flush-mounted in many locations on the outside surface of the lunar satellite, the stubby propeller blade configurations, alternately exposed to intensive sunlight and shadow as the satellite orbits in space, will cover a small area of black heat-absorbing material. When temperatures within the satellite fall below a preset safe limit, a coil device will contract, causing the propeller blades to rotate, uncovering the black heat-absorbing patch to raise the temperature inside the sphere.

When the required upper limit temperature is attained, expansion of the coil control will rotate the heat-reflecting propeller blades to cover the heat-absorbing black patch.

This same propeller blade schems for temperature control now is being checked out in Thor Able III (Explorer VI) satellite orbiting the earth in a long elliptical path.

Large paddlewheel - configuration vanes extending out on arms from the satellite are similar to those used on Explorer VI satellite.

Carried on arms spring-loaded to extend just before third-stage ignition, each cross-hatched vane comprises 2,000 silicon solar cells to take in energy from sunlight and charge batteries for the satellite systems.

Boost Vehicle

Boost vehicle for Atlas Able IV will be the Air Force-Convair Atlas intercontinental ballistic missile, coupled to upper stages as used for Thor Able III. Atlas Able IV originally was intended to put a satellite in orbit around the planet Venus (AW Feb. 23, p. 26), but was rescheduled as a lunar orbit exercise.

Project is part of National Aeronautics and Space Administration's space program, with Space Technology Laboratories designing and assembling the orbiting package.

Pressure Rising for Service Unification

By Ford Eastman

Washington—Demands for unification of the military services and reorganization of the Defense Department hit new peaks last week as members of both the House and Senate urged immediate action to "end waste and confusion" in the Pentagon.

Current organization of the defense and space efforts drew sharp congressional criticism, and concrete proposals for reshaping and streamlining these efforts were made in both Houses. Comments and proposals included:

• **House Government Operations** Committee urged President Eisenhower to initiate studies leading to an Army-Air Force merger. In addition to achieving a unified effort in the development, construction and deployment of land-based missiles, the committee said the merger also should end inter-service conflicts over airlift and tactical support aviation and accomplish integrated planning for tactical and strategic missions. "Problems between the unified military service and the Navy would remain, but these would be of vastly lesser dimension," the committee said. Dr. Herbert F. York, Defense Department director of research and engineering, said recently that work is now under way toward defining the roles and missions of the three services in order to ease inter-service frictions.

• **Sen. Clair Engle (D.-Calif.)**, a member of the Senate Armed Services Committee, touched off demands for reorganization earlier in a Senate speech proposing elimination of service designations and reorganization of the Defense Department on the basis of functions and missions as an "absolute prerequisite" to meeting the challenge of modern warfare. Engle said the present basic difficulty in meeting the Soviet threat is the "multi-headed approach to the solution of defense problems and the bureaucratic quagmire that surrounds the missile and space effort. Reorganization is essential if the U. S. is to survive in the space age."

• **Sens. E. L. Bartlett (D.-Alaska)**, Stuart Symington (D.-Mo.) and John Stennis (D.-Miss.), all members of the Armed Services Committee, as well as Sen. Joseph S. Clark (D.-Pa.) and Sen. Thomas C. Hennings (D.-Mo.) supported Engle's recommendations and urged full consideration of his proposals.

• **Sen. John Sherman Cooper (R.-Ky.)**, a former member of the Armed Services Committee, called upon the President in a television interview to take personal charge of efforts to reorganize the Defense Department in order to eliminate present waste and lack of organization. Cooper said he would offer a bill to eliminate autonomy and duplication of Air Force, Army and Navy by making service secretaries undersecretaries of defense and by coordinating research and procurement.

• **Rep. B. F. Sisk (D.-Calif.)**, member of the House Science and Space Committee, said, "there is no department in government that is more in need of reorganization" than the Defense Department. He added: "It is time to clean out the Pentagon, put all the services in one uniform and get some coordination of responsibility over there." Sisk made his statement during the committee's review of the reasons for cancellations by Air Force and Navy of their boron fuel programs and why the Defense Department proceeded with construction of boron fuel plants after emphasis had been changed from aircra to missiles (see p. 34). Similar opi ions were expressed by Reps. Ken Hechler (D.-W. Va.), Leonard Wolf (D.-Iowa) and Joseph E. Karth (D.-Minn.) of the House group.

Calling for action on the "long and difficult task" of modernizing the defense structure, Engle recommended the following steps as a basis for reorganization:

• **Complete reappraisal** of military and strategic objectives and development of a general plan to permit unification of the services to go forward in logical sequence in a carefully thought-out, time-phased program. The Senate Armed Services Committee should undertake this study as a guide for the Defense Department, Engle said, indicating that a resolution asking the committee to undertake the study would be made later.

• **Abolish the present organizational** structure of the Defense Department, eliminating the designations of Air Force, Army, Navy and Marine Corps and reorganizing on the basis of functions and missions which would include at least a retaliatory striking force, a limited war force, a continental defense and a logistics command.

• **Careful examination** of all problems involved in the merger of the armed forces. The range of difficulties to be considered, Engle said, is enormous, and the steps to be taken should be determined on a priority basis to prevent weaknesses from developing in the interim period.

Martin Bullpup to Undergo Further Development

Martin Bullpup air-to-surface missile, shown here slung under the wing of a North American F-100, will undergo further development at Martin's Orlando Division under a $5 million Air Force contract. Missile will have atomic capabilities (AW July 14, p. 23) and is intended for close-in troop support by Tactical Air Command. Aerojet-General solid rocket gives it a speed of Mach 1.8.

French Drop Long-Range Bomber Program

Paris—Gen. de Gaulle's plan to develop a long-range bomber strike force, with nuclear weapon capability, reportedly has been dropped because of heavy financial costs involved.

Military and civilian sources here claim the government has abandoned its project, announced earlier this year, of developing a larger version of its Mirage 4 attack bomber. Aircraft was to be powered by two Pratt & Whitney J75 turbojets built in France under license by Snecma. The large bomber was slated to be operational by 1964 at which time the French had hoped they would be capable of arming it with French-made nuclear weapons.

Decision to drop the bomber project reportedly was received in mid-August although no official announcement has yet been made. The French 1960 budget presently is under discussion and Finance Minister Antoine Pinay is determined to resist demands of the French military for additional funds to fight an Algeria-type war and at the same time finance a French atomic strike force. For the time being, unless Gen. de Gaulle personally intervenes, the military appears to have decided to put Algerian military demands first.

Reported decision reflects what many military observers here claim is a "sense of unreality" surrounding the current French military thinking. On one hand, the French are pushing ahead with an independent nuclear weapons program and on the other hand are uncertain about their ability to develop and finance an independent delivery system. Some observers say that in the end, the French will have to swallow their pride and attempt to make a deal with the U. S. for either an aircraft or missile delivery system.

Current version of the Dassault Mirage 4 bomber weighs about 50,000 lb. and is powered by two Snecma Atar 9 afterburning turbojets. Range is under 1,000 mi. French had planned to develop the Mirage 4 final version to weigh approximately 125,000 lb. and to be powered by two Pratt & Whitney J75 turbojets. This version, with greatly increased range capability, was to have been France's strategic bomber. About 50 to 80 large Mirage 4s, were slated to be ordered.

Last June Pratt & Whitney and Snecma signed a licensing agreement (AW June 8, p. 28) under which the state-owned French company was to build the J75 in France, mainly for the Mirage program. Pratt & Whitney also took over a 10% interest in the French company as part of the deal. Now, however, significance of the agreement is watered down, although Snecma will maintain and overhaul J75s in Europe.

• **Partial consolidation** of the missile and space programs to eliminate the duplication of military and civilian space activities. Removal of the services from the satellite business and creation of a military applications division within the National Aeronautics and Space Administration to look after military interests. NASA would be barred from booster development except in cases where no military booster could fit its needs.

• **Abolition** of the Advanced Research Projects Agency and transfer of its research activities to the Director of Defense Research and Engineering. ARPA acts as a fifth wheel in the space and missile organization, he said, duplicating the operating functions of the services.

Engle said that a study of the space and missile programs indicates that there is no logical basis for completely separating them. NASA was established to place emphasis on civilian and peaceful uses of outer space, he said, adding that the fact was overlooked that the Defense Department is under civilian leadership and that the "Russians haven't been too thin-skinned about the military operation of their space program."

He said, however, that NASA and the over-all space program have become too well established to completely abolish them and start over again, but that improvements should still be made.

"What I propose is that the development of the satellites and outer space vehicles be done by NASA," he said, "but that, in this development, there be given concern for specific military applications. If the military departments need a space vehicle, that vehicle can be developed by NASA and turned over to the military for its particular type of application. When NASA needs a booster, they should take advantage of what the military has to offer, either in existing hardware or in know-how acquired from developing rockets for weapons. If the military hasn't anything to offer, then NASA can develop its own boosters."

With three of four essential problems involved in going to, remaining in and returning from outer space—propulsion, guidance and re-entry—completely overlapping between the civilian and military applications, Engle said, the two agencies should work closely together. The reason he supports a military applications division in NASA, he said, is to see that this coordination does occur and that duplication of work and overlapping of functions are avoided in the top echelon of the Defense Department and through the operating services.

Engle also criticized the time required to reach decisions. "At the top levels of decision-making," he said, "we find a proliferation of committees. The NASA law created a Space Council. It also set up a civilian-military liaison committee to coordinate space activities. . . . NASA itself has 14 research advisory committees on which military personnel serve and, in turn, there are 34 working groups and committees in the Defense Department on which NASA staff members serve. To complete the jurisdictional complexity and overlap, both NASA and agencies of the Defense Department give assignments to research and development units of the military services.

"As would appear inevitable," he said, "disputes arise as to the priorities and control of certain projects, and the solutions are always compromises which satisfy no one and cause further delays."

Engle said the problems of time-lags is not confined to the missile field alone, that the same faults in the decision-making process appear in the development of all air-weapon systems.

Non-Profit Status Proposed for STL

Washington—Space Technology Laboratories, a wholly-owned subsidiary of Thompson Ramo Wooldridge, "must be converted into a non-profit institution" if it is to continue as technical manager of Air Force ballistic missile programs, the House Government Operations Committee warned last week in a comprehensive report tracing missile programs and problems since the end of World War II.

"An unhealthy situation has developed. Government and private business values have become intermingled to the detriment of both, and there is increasing concern on the part of Congress and the public over the current status and position of STL."

The first step, the committee said, should be a complete divesture of STL by Thompson Ramo Wooldridge.

"If satisfactory arrangements for non-profit status cannot be worked out, the alternative to further unstable relationships is a severance of the Air Force-company tie," according to the committee. "STL would have to go the way of all other contractors and compete in the market for its business."

Vertol Twin-Turbine YHC-1A Makes First Flight

Army-Vertol YHC-1A makes first flight at Vertol Aircraft Corp.'s plant at Morton, Pa. Powerplants are two General Electric T58 turboshaft engines rated at 1,025 shp. each. Strain gages are housed in cylindrical objects above rotor hubs. Elongated duct in leading edge of vertical fin ingests air to cool transmission. Lip on upper aft portion of forward rotor fairing breaks up turbulence.

GE, Bendix to Develop Satellite

Washington—Advanced Research Projects Agency has chosen General Electric Co. and Bendix Aviation Corp. to develop the "Task Steer" polar communication satellite element of communication satellite Program Notus.

General Electric Missile and Space Vehicle Division has received $5.5 million for development of the polar satellite vehicle system, and Bendix Aviation will develop the communications subsystem under a $8.5 million ARPA contract. The two contracts are administered for ARPA by the Air Force.

GE's Missile and Space Vehicle Division also has been chosen by Douglas Aircraft Co. to develop the nose cone for the XGAM-87A air launched ballistic missile.

"Task Steer" polar communication satellite will be a real-time repeater designed to provide instantaneous relay of voice or coded messages between aircraft and ground stations or between two ground stations. Satellite will orbit over the north and south poles, and its primary purpose is to provide reliable communications in the polar area where present communications are frequently disrupted by Arctic atmospheric conditions. Improved polar communications are especially vital to Strategic Air Command.

The polar satellite will orbit at an altitude of several thousand miles, and a number of the communication vehicles will be orbited to provide complete coverage. Booster for the system will probably be the Convair Centaur which uses a USAF-Convair Atlas for its first stage and a Pratt & Whitney liquid hydrogen engine as second stage.

Polar communication satellites will form one element of the family of satellite systems ARPA will develop under Program Notus as a global communications system. In July, ARPA gave contracts to Philco Corp., International Telephone & Telegraph Corp. and Radiation, Inc. (AW July 27, p. 33) to develop ground and vehicle communication elements for Courier, a delayed-relay satellite somewhat similar to the approach used in the Project Score Atlas satellite orbited last December. Courier (see picture, p. 89) will orbit at an altitude of approximately 500 mi.

Program Notus will also include a real-time communication satellite with a 22,400 mi. equatorial orbit which will hover in relation to the earth. This equatorial satellite will provide coverage up to within about 18 deg. of the poles, and the Task Steer vehicles will provide coverage in the polar areas.

Soviet Scientist Details Re-Entry Needs

Moscow—Russian space scientist V. Dobronravov has warned that Soviet accomplishments in rocketing record payloads to high altitudes and returning experimental animals to earth do not necessarily guarantee early success for the safe re-entry of a man-carrying satellite.

Writing in the newspaper Promyshlenno-Ekonomicheskaya Gazeta (Industrial-Economic Gazette), Professor Dobronravov says the two single-stage geophysical medium-range ballistic rockets launched in July "embodied the latest Soviet instrument-making achievements in the fields of physics and radio electronics." He said the containers in which the experimental dogs and a rabbit were carried to high altitude and returned safely to earth were improvments over earlier models.

"Nevertheless," Dobronravov, a doctor of physical and mathematical sciences, declared, "it may be assumed that use of parachute re-entry methods alone, as was the case in launching certain Soviet geophysical rockets, will not suffice in returning a satellite, especially one containing a man. We need a satellite which can also be a unique type of glider—one that has devices to prevent the rocket from revolving around horizontal and vertical axes."

New Space Service Forecast by Pirie

Washington—By the time hostile military forces are facing each other in space, Vice Adm. R. B. Pirie, deputy chief of naval operations for air, predicts that the U. S. will have a separate military service concerned specifically with space warfare.

Adm. Pirie made the prediction while discussing the roles of the services in space at an American Rocket Society meeting here. He also said control of space cannot be considered an end in itself and that, in naval warfare, the use of space will help accomplish routine naval objectives.

"On the other hand, it's equally clear that we will have to be able to prevent the use of space to the detriment of those objectives," he said. "The true naval benefit, therefore, from astronautics will be in being able to carry out old, and continuing, tasks on the earth's surface better than before."

Navy has proposed to the Joint Chiefs of Staff a plan under which a joint Military Space Command would command space system operations, assigning the various systems among the three services for operation (AW July 27, p. 26).

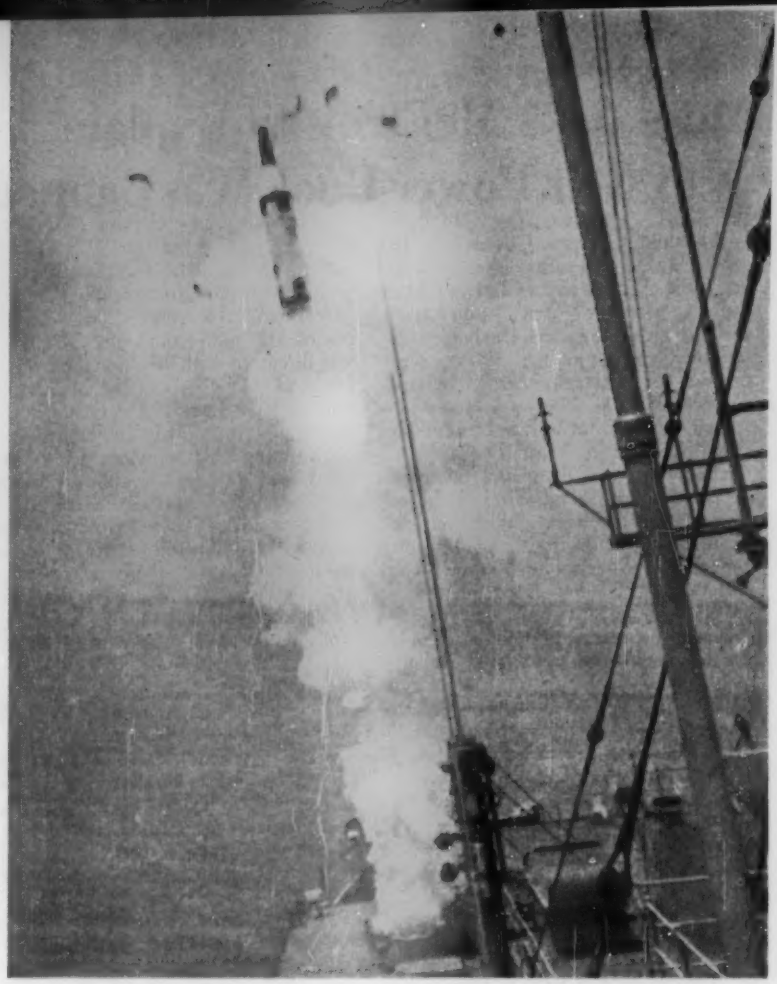
Adm. Pirie said Project TRANSIT (AW Aug. 17, p. 23) is a good example of Navy thinking for the future. TRANSIT is a navigation satellite Navy plans to have in orbit in the 1964-65 period which will provide navigation information to ships and aircraft under all weather conditions. Applied Physics Laboratory of Johns Hopkins University is building the satellite vehicle.

Navy also is interested in counter-space systems, Adm. Pirie said, and the anti-missile missile "will best be launched from naval ships at sea" because of the uncluttered environment and choice of launching sites.

Discussing manned space vehicles, Pirie observed that they are now completely in the hands of the National Aeronautics and Space Administration and the point when the military services will get manned vehicles is not discernible because of present Administration policy. He said that when the military needs a manned vehicle, the Administration in office will then have to decide which service will get it.

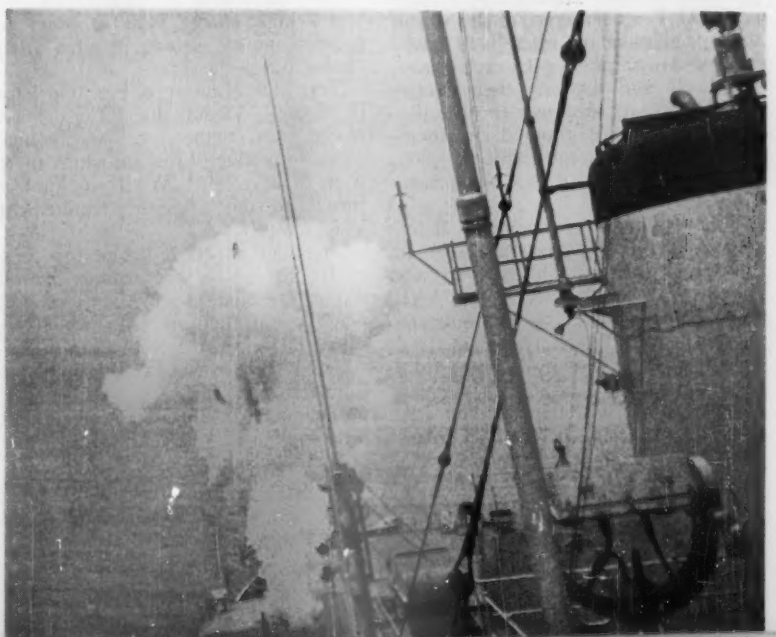
Navy astronautics program, exclusive of research and development aspects, has been placed under Pirie's command, and he predicted that in the future the Navy space role will "become more pronounced—and more and more apparent to the public."

Adm. Pirie also said that the Polaris fleet ballistic missile now under development by Lockheed Aircraft can be used as a booster for space application and can launch payloads of at least 50 lb.



Polaris Launched From Observation Island

Navy-Lockheed Polaris was fired at sea from USS Observation Island for the first time in this launch while the ship cruised at 5 kt. off Cape Canaveral. Polaris test vehicle was launched by compressed air from a cylinder in the ship's deck similar to the launching tube designed for submarines. First stage ignited when the missile was about 70 ft. above the deck. Observation Island was ballasted to list 5-10 deg. so that Polaris would be fired at an angle and would not fall back on the ship in case of a malfunction.



Moss Asks McElroy to Explain Why Gen. Power Book Was Banned

Washington—House Government Information Subcommittee asked Defense Secretary Neil McElroy last week to explain why he barred publication of "Design for Survival," a book written by Gen. Thomas S. Power, commander of Strategic Air Command (AW Aug. 31, p. 29).

In a letter to McElroy, Subcommittee Chairman John E. Moss (D.-Calif.) requested "an immediate and complete explanation" of the procedures followed in reviewing the book and the authority used in prohibiting its publication. Sen. Stuart Symington (D.-Mo.) also criticised the Defense Department ban on "Design for Survival."

Power was denied permission to publish the book under a Defense Department policy which bars top civilian and military defense officials from writing about their offices or commands while they still hold them. The Department said its disapproval applies only to a copyrighted book and that Power is free to express his views through such media as speeches and interviews.

Moss pointed out that the Power book had Air Force approval, and he quoted a memorandum from former USAF Under Secretary Malcolm A. MacIntyre which said all the material in "Design for Survival" is from open sources available to the press and existing in printed public form or cleared congressional testimony. He said much of the material was in speeches made by Power and other top civilian and military leaders.

Noting that the opinions in the manuscript were Power's and shouldn't be interpreted as official Defense Department or USAF policies, MacIntyre said: "Air Force clearance of this manuscript is given in the interests of allowing professional airmen to express constructively and logically their professional views and ideas as a contribution to military science, thought and literature. This is in accord with past Department of Defense policy and instructions on this matter."

Subcommittee investigation determined that the manuscript went to Defense Department Office of Security Review on April 21 after it had been reviewed in Air Force headquarters. Air Force approval, after recommended security changes were made, came from the Assistant Chief of Staff for Guided Missiles, USAF historian and the deputy chiefs of staff for materiel, plans and programs and operations and intelligence.

The manuscript was returned to the Air Force by Murray Snyder, Assistant Secretary of Defense for Public Affairs, and revisions were made. It was returned to Snyder July 2 accompanied by the MacIntyre memorandum. After further comment from Snyder's office, the issue was discussed with Air Force Secretary James H. Douglas, and the manuscript was submitted again for Defense Department approval. It was denied.

Outlining this sequence of events, Moss said the investigation indicates that denial was based on DOD 5230.9, a directive which formerly set a "constructive contribution" standard for issuing information. This was amended in August, 1957, to require that information must not conflict with "established policies or programs of the Department of Defense or those of the national government."

A second basis for refusal was the policy produced by a meeting in 1954 between former Defense Secretary Charles E. Wilson and the service secretaries, which controls writing of books and magazine articles by top defense officials. Moss said Defense Department officials admit this policy has never been put in writing.

Moss told McElroy that whether or not there is agreement with the ideas expressed in "Design for Survival," "it seems imperative that the American public should have access to those ideas in book form—particularly when the comments already have been made in public speeches and testimony."

In his letter, Moss quoted the preface to the Power book in which the SAC commander said he wrote it because of a growing awareness among the public "that the military problems of survival are no longer the sole concern of the men in uniform and their civilian superiors." Power said he was encouraged by the interest shown by private citizens, and that he feels it is important to present the situation to the public frankly and in simple terms.

Power said his book was written for the American people with the conviction that "we cannot solve the problems entailed in our design for survival unless the people fully understand these problems and decide to do something about them.

"This country has had problems before, and it has always managed to cope with them once it gained the understanding and support of its citizens," Power said. "Still, none of the dangers we have faced in the past can compare to the formidable threat of nuclear aggression which we are facing today. Nor will we ever again have the time to plan, to rally and to act after the aggressor has struck. If he were to strike today, he would find us ready to strike back but ill prepared to ward his blow."

Military Requirement Demanded To Save Boron Fuel Investment

Washington—Members of the House Science and Space Committee last week warned the Defense Department to "come up" with a requirement for boron high energy fuels in order to prevent money already invested from "going down the drain."

Rep. James Fulton (R.-Pa.) told John B. Macauley, deputy director of defense research and engineering, "No one here wants to produce a fuel for which there is no requirement. What we want is for you to come up with a requirement and promptly."

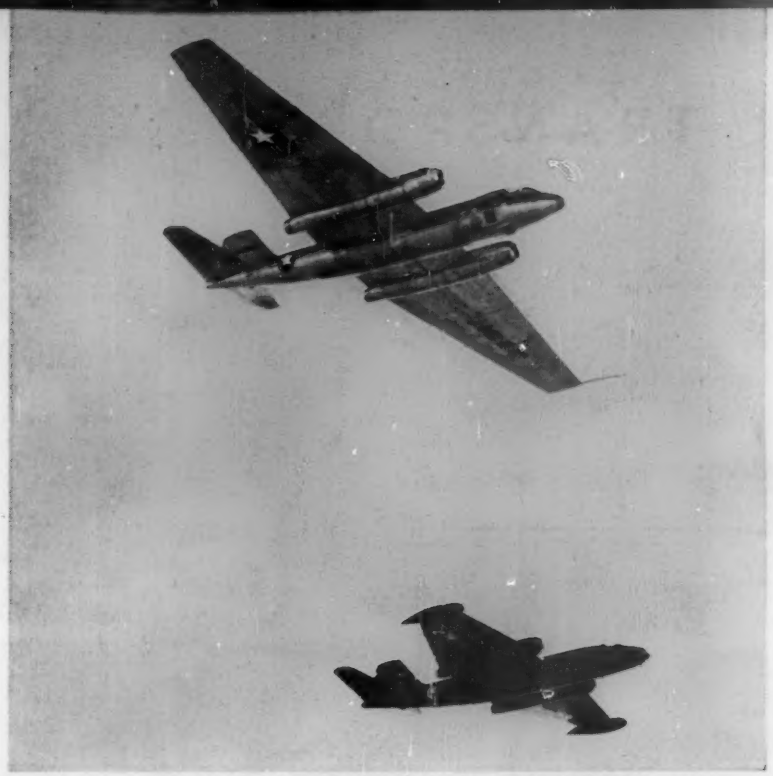
Macauley appeared before the committee to explain the reasons behind recent cancellation of Air Force and Navy boron fuel programs which resulted in the closing of two newly constructed five-ton-a-day fuel plants shortly before they were to go into production (AW Aug. 17, p. 26). About $240 million has been expended on the program to date.

Fulton said he was distressed by the lack of decision and aggressiveness on the part of the Defense Department in not keeping the program alive and preventing the money already expended from going to waste.

Rep. Overton Brooks (D.-La.) committee chairman, who noted it had been approximately two years since Sputnik I was launched and the U. S. shifted emphasis from aircraft to missiles, asked why it had taken from October, 1957, to this summer to determine that there was no longer any requirement for high energy fuel. "Had a prompt decision been made after Sputnik I, we would have saved the better part of $200 million," Brooks said.

Macauley backed the testimony of earlier Air Force and Navy witnesses who said that the two services no longer have a requirement for the high energy fuel and that early engine tests cast considerable doubt on the fuel's ability to attain the improved performance that had been expected (AW Aug. 31, p. 30).

Macauley said the first estimates of the improved performance of boron fuels over conventional ranged upward



First Photo of Martin RB-57D

First official photo of Strategic Air Command's RB-57D high-altitude reconnaissance ship shows the major redesign necessary to develop the aircraft from the original Martin RB-57A (lower plane) medium bomber used by the Tactical Air Command. Most obvious alterations include incorporation of Pratt & Whitney J57 turbojet engines developing 10,500 lb. thrust each and a large increase in wing area accompanied by changes in the airfoil sections. The high-altitude aircraft does not require vortex generators used on the wing of the RB-57A. Design load factor of the RB-57D is much lower than that of its low-altitude predecessor, giving it a very low structural weight. This feature, plus the added wing area and improved engines, is the key to its altitude capability. Aircraft served originally as a testbest for the J57; bomber version is powered by two 7,200 lb. thrust Curtiss-Wright J65 engines.

from 50%. He added, however, that the most recent studies show that improvement is negligible at subsonic aircraft speeds and moderate at supersonic speeds.

In addition, he said the fuel cost has not been reduced to the point expected. In 1954, it was estimated by the contractors that a fuel cost from 60 cents to $1 a pound would be possible at a moderate level of production, Macauley said. The estimate for the five-ton a day plants is around $5 a pound, he said, with improved processes and larger scale production possibly bringing the cost to below $2 a pound.

Earlier, however, Dr. W. H. Schechter, Callery Chemical Corp. vice president, testified that he regarded the boron fuel program as neither a failure nor a mistake.

Schechter, who termed the program a major technical and industrial achievement, said that even though Air Force requirements no longer exist for the J93-5 engine, boron fuel still delivers 4% more energy than conventional fuels and that it appears practical for jet engines and promising in missile propulsion programs.

Schechter said other military requirements are likely to develop for aircraft or missiles utilizing turbojet and ramjet engines that can best be powered by boron fuels. The impetus of the Air Force and Navy fuel programs has touched off a variety of research projects at the university level in a number of new areas which are likely to result in other major developments, he said.

Because of possible future uses of boron, Dr. Schechter suggested the Muskogee plant be used for interim production of the fuels at partial capacity. It also is possible, he said, that the non-process portion of the plant, consisting of administrative buildings, shops, steam plant, and water system, could be utilized in the production of other military or industrial chemicals.

"If the termination order is effective in its original form," Schechter testified, "it will be a knock-out blow" to Callery, whose efforts have been devoted almost entirely to the boron fuel program.

Future use of either or both of the two plants will depend to a large extent upon an engineering study being conducted by the Arthur D. Little Co. of Boston. Results of the study will be submitted to a meeting of Defense Department's Joint Working Group on Special Fuels on Sept. 10, which, in turn, will make its recommendations as to the fate of the plants to Defense.

News Digest

North American B-70 Mach 3 bomber wingtips will fold downward in flight to assure maneuverability and stability at high speeds. Boeing Airplane Co., subcontractor for the delta wing, awarded Curtiss-Wright's Propeller Division a contract for actuators for the folding mechanism.

First tactically operational model of the Mach 2 Convair B-58 Hustler bomber is scheduled to make its first flight at Convair-Ft. Worth, Tex., early this month, signaling the start of delivery to USAF of combat-type Hustlers.

Pan American World Airways last week averted a threatened strike by its flight engineers by reaching an agreement covering certain jet crew functions. The agreement spells out that the third officer will not be used in any flight engineer functions on the aircraft. Flight engineers had contended that some captains were training the third officers in some flight engineer duties and causing "confusion in the cockpit."

General Electric Co.'s Small Aircraft Engine Department received its first order for CT58-100 turboshaft engines (1,050 shp.) from Sikorsky Aircraft for use in the S-61 and S-62 helicopters.

Maj. Gen. John W. Sessums, Jr., retired vice commander of Air Research and Development Command, has been named board chairman of Grand Central Rocket Co., succeeding Joe J. King, senior vice president of Tennessee Gas Transmission Co., which has an interest in the firm.

Avco Corp.'s Research and Advanced Development Division will do basic research and develop prototypes for the re-entry vehicle of the Minuteman solid fuel intercontinental ballistic missile (AW June 8, p. 59) under a $36,655,000 Air Force contract.

Two white mice are being sustained in a sealed glass and plastic case by Chance Vought scientists, in a test of a closed ecological system that could apply to future space explorations.

EJECTORS which are part of Douglas DC-8 sound suppressor units are extended on this Delta Air Lines transport in traffic pattern. Ejector cuts sound and increases takeoff thrust to offset loss caused by tailpipe daisy-type nozzles (AW Nov. 17, p. 91).

FAA Presents DC-8 Type Certificate

United, Delta plan to begin service on Sept. 18; model with JT4 scheduled for December approval.

By L. L. Doty

Baltimore, Md.—Federal Aviation Agency last week formally presented Douglas Aircraft Co. with a type certificate for the DC-8 transport powered by four Pratt & Whitney JT3 turbojet engines at ceremonies at Friendship Airport to clear the way for the simultaneous entry of United and Delta Air Lines into U. S. jet competition on Sept. 18.

United Air Lines, which has been forced to juggle schedules to meet Boeing 707 competition by American Airlines and Trans World Airlines and to cut schedules so that pilots could be withdrawn from service for jet training, will enter the competitive race with one daily nonstop round trip flight between San Francisco and New York on Sept. 18.

Delta, which thus far has had no back-to-back jet competition on any of its routes, will launch its DC-8 service on the same day with one round trip daily between New York and Atlanta. On Oct. 15, the carrier will expand its service to include turbojet flights between Chicago and Atlanta and between Atlanta and Miami.

Thus Delta moves into the jet race well ahead of its principal competitor, Eastern Air Lines, which chose to wait for delivery of its fleet of 16 DC-8s until the aircraft powered with larger P&W JT4 turbojets are available in order to avoid future conversion costs.

According to Donald Douglas, Jr., Douglas Aircraft president, certification of this JT4-powered model is now scheduled for December, with certification target date for the Rolls-Royce Conway model set for February of next year.

Delivery Schedule

Eastern expects delivery of its first DC-8 in November so that it can start training at that time and begin scheduled service in January. National Airlines, which has three JT4A-powered DC-8s now on order, also plans to inaugurate service at the first of the year.

Of the 143 DC-8s on order, 24 are powered with the smaller JT3 engines. C. E. Woolman, Delta president, told AVIATION WEEK that his company ordered the six DC-8s with the JT3 engines in order to avoid any unnecessary delay in beginning service. He said the company plans to convert the aircraft to the larger powerplants or to turbofans at a later time.

Conversion Plans

United President W. A. Patterson also said his company plans to convert the 18 DC-8s equipped with JT3 engines to either turbofan or JT4s after three or four years of service. United has a total of 40 DC-8s on order at a cost of $225 million.

Patterson has often acknowledged that his decision to buy the DC-8 in preference to turbojet transports immediately available for delivery put United at a competitive disadvantage. However, he once noted that ". . . the long-term advantages of the DC-8 would outweigh this temporary disadvantage and that any diverted traffic would be regained quickly when DC-8 jet Mainliner service begins."

Last week, he enlarged upon these "long-term" advantages during formal presentation here of type certification to

UNUSUAL view of three DC-8 jet transports in formation; two are in Douglas markings and the third in United's. The aircraft flew 2,284 hr. in Douglas flight tests prior to last week's certification and made 1,782 landings during the test phase.

DELTA DC-8 flew from the Douglas Aircraft plant at Long Beach, Calif., to Miami, Fla., in 4 hr. 43 min. Configuration is for 119 passengers, including seven seated in the lounge.

SIDE VIEW of United's DC-8 emphasizes ejector in extended position. Unit has clamshell doors which can be closed for thrust reversing action during landings. N8005U is powered by four Pratt & Whitney JT3C-6 engines rated at 13,000 lb. thrust each.

Douglas Aircraft by the Federal Aviation Agency:

• **Speed of turbojets** will not be an immediate factor in creating obsolescence of aircraft as was the case of piston-engine aircraft. On the other hand, fixed passenger comfort can create a degree of obsolescence as service patterns change. Interior of DC-8 provides aircraft with a long-range selling advantage, in United's opinion.

• **Increase in weight** sometimes destroys economic balance of an aircraft. DC-8 can absorb certain amount of increase in gross weight without sacrifice to payload, according to Patterson.

• **United found DC-8** to be "easiest to fly" and more advantageous from a flight operation point of view.

Agreeing that these factors were also instrumental in Delta's decision to buy the DC-8, Woolman added that his company chose the aircraft because of its "confidence in the Douglas product."

Type Certification

Type certificate for the airplane was presented to Donald Douglas, Sr., chairman of the Douglas board, by E. R. Quesada, Federal Aviation Agency administrator, during a luncheon at Baltimore's Friendship International Airport.

Although type certification of the DC-8 was completed a month in advance of the original target date of Oct. 1, actual certification was granted only 24 hr. ahead of the luncheon ceremonies arranged by Douglas to publicize the certification. Special flight of a DC-8, powered with the JT4 engines, from Los Angeles to Baltimore one day prior to the ceremony was used to conduct the last phase of the functional and reliability tests of the type certification program. The aircraft was flown here to be used for guest flights arranged as part of the presentation ceremonies.

Douglas accelerated its certification program as a means of getting the DC-8 into scheduled service at the earliest possible date to prevent the Boeing 707 from getting too large a lead in the jet race. However, FAA inspectors, backed by a personal warning from Quesada that no short-cuts were to be taken, followed certification procedures to the letter during the entire program.

Douglas made the decision to build the DC-8 in 1955. Drawing board stage began in 1952. Since the production model took to the air for the first time on May 30, 1958, DC-8s have made 1,782 take-offs and landings and logged a total of 2,284 hr. of flight. This includes 1,302 hr. of instrumented tests under all operating conditions.

On the pre-ceremonies flight from Los Angeles to Baltimore, the JT4-powered DC-8 flew the coast-to-coast distance in 4 hr. 34 min. Takeoff weight was 255,000 lb. gross and initial climb was at 2,000 fpm. On cruise portions of the flight, average speed was 553 mph., while maximum speed on any one flight leg was 595 mph.

Cruise altitude was 33,000 ft. initially. To avoid turbulence at one point, the plane climbed to 37,000 ft. The plane was certificated to operate up to 42,000 ft. and will have an operating-takeoff gross weight of 273,000 lb.

Landing weight on the flight was 188,000 lb. The aircraft used 67,000 lb. of the 110,000 lb. of fuel it carried. Douglas engineers reported that no mechanical items on plane required attention of maintenance crews after landing.

Behind the trailing edge of the wing, the fuselage is equipped with a series of hat-sections incorporated for additional stiffening to minimize sound level in the aft cabin area. This structural feature provides the equivalent of raising skin gage from .040 to .078.

Beginning with the 30th DC-8 to come off the production line, wing slots will be installed on four sections of the wings—two on each wing. Two 34 in. sections will be located inboard of the inboard nacelle, and two 80 in. sections will be located between the two nacelles. Wing slots will cut stall speed 10 kt. and reduce roll on take-off by 1,000 ft.

Delta will operate its DC-8s with 40 first-class seats, 72 coach seats and a seven seat lounge, for a total of 119 seats. Service will begin with two airplanes and will be increased in October when a third will be delivered. Delta Air Lines is scheduled to receive its entire fleet of six by the end of the year.

United will expand its initial service in October to include Los Angeles-New York, San Francisco-Chicago and Los Angeles-Chicago flights. In November, service will be introduced on the West Coast between Los Angeles and San Francisco and from San Francisco to Chicago and Washington.

Six aircraft will have been delivered to United when service begins next week. By the end of the year, 16 will have been delivered, and a total of 32 is scheduled to have been delivered by the end of 1960. United will have all 40 of its DC-8s by the summer of 1961.

United's DC-8s will carry 52 first-class seats and an eight-seat first-class lounge. Coach section will have 48 seats, with a five-seat lounge. All lounge seats on both Delta and United's planes will be saleable.

Both airlines will use four stewardesses on jet flights.

Eighteen commercial airlines have ordered the DC-8. They are: Alitalia, Delta, Eastern, Japan Air Lines, KLM, National, Northwest, Olympic, Pan American, Pan American-Grace, Panair do Brasil, Philippine Air Lines, SAS, Swissair, TAI, Trans-Canada, UAT and United.

DC-8 Cargo Version

Baltimore, Md.—Douglas Aircraft Co., looking to airfreight as the next big field of transport expansion, is building an all-cargo prototype of the DC-8 to be completed next year.

The aircraft will be a swing-tail cargo plane and will be powered by Pratt & Whitney JT3D turbofan engines. The plane will be designed to operate in the direct operating cost area of four cents a ton-mile. According to Donald Douglas, Sr., no orders for the aircraft have been received, but the company expects that a number of sales will be made.

Douglas officials noted that the sale price of the DC-8 turbojet transport, ranging from $4.2 million to $6 million, depending on interior requirements, will not cover developmental costs of the DC-8. However, sales of the DC-8 cargo version are expected to enable the manufacturer to pass its break-even point.

The aircraft will include a sophisticated system of cargo handling, based on Douglas C-124 and C-133 experience.

Flying Tiger Outlines CL-44D Route Costs

Los Angeles—Rates between six cents per ton-mile and 20 cents per ton-mile, with an average return of about 13.5 cents per ton-mile, were forecast by Robert Prescott, Flying Tiger Line president, in speaking of the Canadair CL-44D turboprop air freighter his company will place in service in 1961.

Prescott, speaking at a joint meeting of the American Society of Traffic and Transportation, Inc., and Los Angeles Transportation Club here, said the first of the 10 planes, worth $48 million, is expected to enter service in the spring of that year.

If scientists, through the use of chemical additives, double the power of today's (turbine type) fuel, then "the long haul truck will go the way of the pony express," Prescott said. He cited these figures concerning the Canadair airplane, which is a swing-tail adaptation of the Bristol Britannia—a payload of 73,000 lb., coast-to-coast speed of 400 mph., a cubic capacity of 7,391 cu. ft. (for cargo density of approximately 10 lb./cu. ft.).

Another point Prescott dwelt on was the costs—operational and fixed. He cited the average fixed cost per airplane per day, which is estimated to be $2,500 for the CL-44D, covering depreciation, taxes and insurance. At a utilization rate the same as obtained with the line's Lockheed Constellations today,

Newark Control Tower Readied

Newark Airport's new $1,750,000 control tower, almost complete structurally, now is being furnished by Federal Aviation Agency with $1 million worth of electronics and other equipment. Tower is circular at ground level with 78-ft. diameter at that point; a 117-ft. concrete shaft supports the upper structure. FAA will staff the facility with 16 electronics specialists and 58 air traffic control specialists.

10 hr. per day, this reduces to $250 per flight hour.

"If we can push this utilization to 16 hr. per day with the CL-44, our fixed costs would be reduced to $155 per hour, a saving of about $100 per hour. If you carry the arithmetic out, 16 hr. a day is 6,000 hr. per year, and if you save $100 per hour, you have saved $600,000 operating cost on each airplane per year.

"We believe this kind of improvement can be brought about in the CL-44, principally by the time saved in loading and unloading through the swing tail . . . and the greatly reduced ground maintenance time required for a turbine-powered airplane versus the piston," Prescott said.

The effort to improve utilization will entail some "radical changes in scheduling from our present method," he said; today's shippers are used to regular late night departures at origin and early morning arrivals at destination.

"We don't yet know exactly how we are going to bring it about, but in the new jet era we will have to schedule the flights on an around-the-clock basis in order to achieve low costs. It may be that there will be a tariff separation between shippers who want the fast overnight schedules and those who can wait for a second day delivery. Perhaps we may do it on a commodity separation basis. It will be one of our toughest problems, and I assume we will end up solving it on a trial and error method," he declared.

Another radical change that will come about, Prescott said, will be in tariffs.

"Today, coming westbound, we charge the same price for every commodity we carry, without regard to such factors as ease of handling, value of service or many other factors that enter into tariff making. This we know is not the best tariff policy, but we have had no opportunity thus far to correct it.

"We now have an intensive research program under way. Upon the results of this we will construct a new tariff. We expect to have rates on various commodities ranging from as low as six cents per ton-mile (with the CL-44D)."

Forecasting traffic, Prescott noted that "today we are doing slightly better than 80 million ton-miles annually. The CL-44Ds . . . have an annual all-up capacity of five hundred million ton miles—or about one half of what the total airfreight industry, domestic and international, is doing today.

"By 1965 we expect the industry to be doing 7 to 10 billion ton-miles with our own company flying 600 to 700 million ton-miles," he said.

Aerolineas' Comet May Be Total Loss

New York—Aerolineas Argentinas Comet 4 jet transport which made a crash landing Aug. 20 short of the runway at Asuncion, Paraguay, may be a total loss, leaving the carrier with a fleet of two jets until further deliveries next year, officials said here last week.

The Comet, coming into Asuncion on an ILS approach after a flight from Buenos Aires, hit about 6 mi. from the airport in a clear spot surrounded by trees and sloping terrain. The captain was killed in the first impact and two of the other six crewmen were injured seriously. The 54 passengers aboard were able to deplane, but one woman died shortly afterward, reportedly from a heart attack.

The airline was not sure last week whether the plane, now resting in a highly inaccessible spot, can be recovered and repaired. Weekly round trip schedules between New York and Buenos Aires have been cut from three to two and a reduction in Buenos Aires-Santiago flights from five to three a week is under consideration. The Argentine carrier also flies two weekly round trips between Buenos Aires and Europe with its Comets. Three more of the British jets are scheduled for delivery next year to Aerolineas.

The airline has been using Asuncion instead of Rio for Comet stops since mid-August because of runway deterioration at Rio caused by the jet blast, according to the carrier. It hopes to see early completion of a runway strengthening program at Rio so it can resume service there and end the loss of traffic in and out of the Brazilian city.

707 Crash Prompts Restudy of Training

Riverhead, N. Y.—Re-evaluation of training maneuvers such as two-engine-out approaches will result from investigation of the Aug. 15 fatal crash of an American Airlines Boeing 707-120 jet transport attempting to land at the Peconic River Airport, Calverton, Long Island, N. Y. (AW Aug. 31, p. 39).

According to testimony at a Civil Aeronautics Board hearing here on the accident, most witnesses said the aircraft, which had been cleared to land on Runway 23 at the Grumman-operated field, banked left, recovered, and then entered a right turn which became progressively steeper until the plane went almost vertically down.

The student pilots aboard the jet were in the sixth period of their transition instruction, which would probably encompass maneuvers that simulate a jammed stabilizer condition, an inoperative stabilizer and/or additional engine-out landings.

Following the accident, American Airlines suspended two-engine-out jet approaches except under certain restrictions: the second engine was not to be cut back until the aircraft was going straight in for its landing. Federal Aviation Agency later directed that 707 maneuvers involving simulated failure of two engines on one side be performed "at altitude," pending results of the crash investigation.

Maneuver Required

Prior to this Aug. 26 directive, the simulated two-engine-out maneuver at low altitude was required for type rating checks and captains' six-months type proficiency checks in all four-engined aircraft.

One indication that the 707-120 involved in the accident was maneuvering with its two right engines idling was provided by readings of its oil temperature gages, which showed temperatures at impact of 105 deg. on engines No. 1 and 2, compared with 70 deg. and 74 deg. respectively for engines No. 3 and 4.

Development of information for a re-evaluation of the training maneuver was begun during the hearing, which was the operational part of a two-phase investigation and will be followed in a few weeks by a hearing on the structures group's findings.

Several 707 pilots testified during the hearing as to operating characteristics of the plane under certain flight conditions and on instructor techniques used in the training program. During their testimony, each was asked whether he felt anxiety or apprehension during two-engine-out maneuvers. J. R. Gannett, Boeing senior transition and training pilot; Glenn H. Brink, American Airlines 707-120 captain; and Howard U. Morton, American Airlines 707-120 captain replied that they felt no apprehension and considered the maneuver a desirable part of training.

Oscar Bakke, CAB Bureau of Safety director and a member of the board of inquiry in the hearing, developed this line of questioning. He said later that considerable additional information on the subject will be accumulated and the desirability of such maneuvers will be carefully re-appraised.

Gannett of Boeing described flight tests the manufacturer had run since the accident, including use of air brakes and lateral control simultaneously with inboard spoilers off (simulating a jammed stabilizer condition). He noted no unusual response. He yawed the aircraft left and right with full control application to obtain flight recorder airspeed response to yawed flight. Power was symmetrical during these yawed conditions.

Gannett reported an experience during a training flight in which he was turning downwind after takeoff and setting up for a two-engine landing. As he gradually eased back on two engines, his student applied aileron but no rudder. The student then applied just a little rudder; the plane began to yaw and roll 60-70 deg. toward the power-on engines. Gannett took over, applied full rudder and brought the aircraft back.

According to the Boeing pilot, two other airline operators of the 707-120 have experienced similar control situations where students made rudder errors and instructors had to take over. One incident involved a 3,500-ft. altitude loss, another a 1,000-ft. loss and a third a 5,000-ft. loss, Gannett said.

From the stabilizer setting of the wrecked plane, Gannett said, it is unlikely that a jammed stabilizer approach was being made.

Capt. William A. Reedholm, superintendent of flying for American Airlines, testified that the airline had recently run tests to determine how long it takes the airplane to recover from induced yaw rolls. At 170 kt. airspeed, power on engines No. 1 and 2, gear down, 30 deg. flaps, and holding rudder to maintain straight course, time to roll from 30 deg. left to 30 deg. right was 10 sec., Capt. Reedholm said. The nose then started down.

Evasive Action?

Capt. Reedholm agreed with Gannett that evasive action to avoid other traffic should not have caused the jet to roll during its approach before the accident. This possibility was raised by testimony of several witnesses who had noticed a lightplane in the vicinity at the time, and by the testimony of Sgt. Harold Mahoney, a Suffolk County AFB crew chief and owner-pilot of a Piper J-3 Cub.

Sgt. Mahoney said he was flying the red and white Cub at 300 ft., operating out of a farmer's field nearby. He had been flying out of the field for about two months, he said. The field has not been inspected by FAA, is not on aeronautical charts, and he had no agreement with Grumman's tower about operating in the vicinity of its pattern. The Cub had no radio.

He first sighted the jet, Sgt. Mahoney testified, when it was about 800-1,000 ft. away approaching on a perpendicular course from his left. The 707 turned left, he said, then its right wing went down and the nose went down. It rolled on its back and hit that way, Sgt. Mahoney said.

"He was above me when I first saw him but when he went into a spin I just wanted to get out of there," the airman testified. Before that, he saw no need for evasive action. There was about 500 ft. of altitude separation, he said. He estimated that the 707 was at about a 10 o'clock position from the Cub when he first sighted it and the Cub was between one and two o'clock from the jet.

Samuel Gates, American Airlines attorney, questioned Sgt. Mahoney vigorously and some of his queries were ruled

Turbofan DC-9 Studied

Baltimore—Douglas Aircraft Co. is studying twin-engine versions of its DC-9 short-medium range jet transport. Pratt & Whitney 17,000-lb.-thrust JT3D turbofan engines are favored in the twin-engine model which will be designed for wing mounted pods.

Douglas is not considering rear mounted engines because of its long-term experience with wing pods and because it believes center of gravity becomes a very critical item in rear mounted engines and can prevent switch to heavier engines.

Four-engine DC-9 would use Pratt & Whitney 8,250-lb.-thrust JT10A turbofans. Douglas said several customers are interested in the twin-engine version.

United Air Lines' board of directors has authorized expenditure of funds to equip four of the 18 DC-8s now earmarked for JT3 turbojets with JT3D turbofan engines. No action has yet been taken on the authorization, however, and no contract has been signed with Pratt & Whitney for the new powerplants.

out of order by Claude M. Schonberger, CAB hearing officer. One question was whether the airman was familiar with Civil Air Regulations. Schonberger considered this outside the scope of the investigation.

Preliminary data from the structures group introduced at the hearing indicated that the American plane hit the ground at an impact angle of about 25 deg. on a 285 deg. magnetic heading. Position at impact was about 15 deg. nose down attitude, yawed slightly to the left and slightly right-wing-down. Landing gear and 30 deg. of flaps were extended at impact and there were 1¼ units of airplane nose up trim. While impact damage might have made the trim tab readings inaccurate, the stabilizer trim switch on the copilot's side indicated 1.78 deg. nose down; on the pilot's side, the stabilizer trim switch reading was full deflection nose down.

Speed brake handle was in an eight degrees position, indicating spoilers up eight degrees. Manual stabilizer control handles were both in. Left side stabilizer trim switch was in half-way position, indicating "on" position; right side Mach trim switch was ¾ toward the on position, indicating "on". The major portion of the aircraft was consumed by fire after impact.

The structures group's preliminary report found no major discrepancy in a cursory examination of the aircraft maintenance records. Consensus of pilots who had flown the aircraft was that it functioned normally and was a good plane.

The report noted an inflight control incident experienced with the plane on the day before the accident with another crew under Capt. C. H. Rickards. According to Capt. Rickards' statement, he set up a jammed stabilizer condition, 1½ deg. nose down, while descending to enter the Peconic pattern. The captain asked his student pilot to demonstrate a jammed stabilizer trim by the split spoiler method. Altitude was 2,000 ft. and airspeed was 190 kt. The student properly deactivated the inboard spoilers and started an easy turn to the left in order to circle the field. While applying left aileron, he pulled up the speed brake handle to 30 deg.

Increasing Roll Rate

This resulted in increasing the roll rate to the left to about 45 deg. of bank and the student immediately applied right aileron. Capt Rickards couldn't determine whether the 45 deg. bank was caused by the speed brake application or by too much aileron control application. No flaps were extended at the time. With zero flaps, the outboard ailerons are locked out. In this maneuver, with a nose heavy condition, it is necessary to deactivate the inboard spoilers and use the outboard spoilers to get pitch up.

This results, Capt. Rickards said, in sufficient stick travel to flare the aircraft during landing. With inboard spoilers deactivated and outboard aileron locked out, the aircraft's lateral control has been reduced 50%. When the student applied opposite aileron, the aircraft stopped its roll to the left. The student then put the speed brake handle full forward, and opposite aileron returned the aircraft to level flight.

American Wins Nonstop Rights

Washington—Civil Aeronautics Board last week authorized nonstop rights between San Francisco and New York for American Airlines on grounds that the traffic potential of the market and the stimulating effects of jet service in the development of new traffic warrant a third carrier on the route.

This is the first time that the Board has based a route decision almost entirely on the influence of new equipment on traffic potential—in this case the inauguration of turbojet transport schedules on transcontinental routes. Prior to this decision, only United Air Lines and Trans World Airlines have been authorized to provide nonstop service between the two points. American will start the service Nov. 1.

Northwest Airlines was an unsuccessful contender in the case. The Board turned down Northwest's petition on grounds that American had already established identity in the market "which can be readily harnessed to stimulate the new nonstop service."

Board Chairman James Durfee and member Harmar Denny took sharp issue with the majority opinion which estimated that normal traffic growth in the market during the next three years will amount to 33%, with an additional 10% to reflect jet stimulation in 1960.

In their strongly worded 25 page dissent, Durfee and Denny said "the record is not ripe for a Board decision" and criticized the majority action on the following grounds:

- **Record contains no evidence of economic or operational impact of jets.**
- **Public need for added competition over the route was not proven.**
- **Traffic volume forecast by the Board is insufficient to support three carriers.**
- **Addition of American in the nonstop market will cause heavy revenue diversion from Trans World and United.**

In its opinion, the majority found that past services provided by United and TWA did not fully meet the needs of the traveling public, and they added:

"The evidence clearly shows that during and prior to 1957 it was difficult for the traveler to obtain his choice of schedule or departure time on nonstop coach flights during peak periods."

The majority admitted that plans to inaugurate a full schedule pattern of jet nonstop service will create a substantial amount of additional capacity in the New York-San Francisco market. However, they noted that the market potential which exists will be "substantially enhanced by the unique advantages of jet aircraft" and that the "authorization of a third carrier holds the greatest prospect of the full development of that potential."

The majority was enthusiastically optimistic over the prospects for traffic growth. In a statement that was clearly a direct reply to charges by the majority of trunklines that competition was too strong on most major routes, the majority concluded:

"Despite the addition of a substantial amount of new competitive service in many markets during the past several years, the aviation industry has continued to grow and prosper and the number of passengers being transported . . . has increased year by year." They forecast a continuation of that trend.

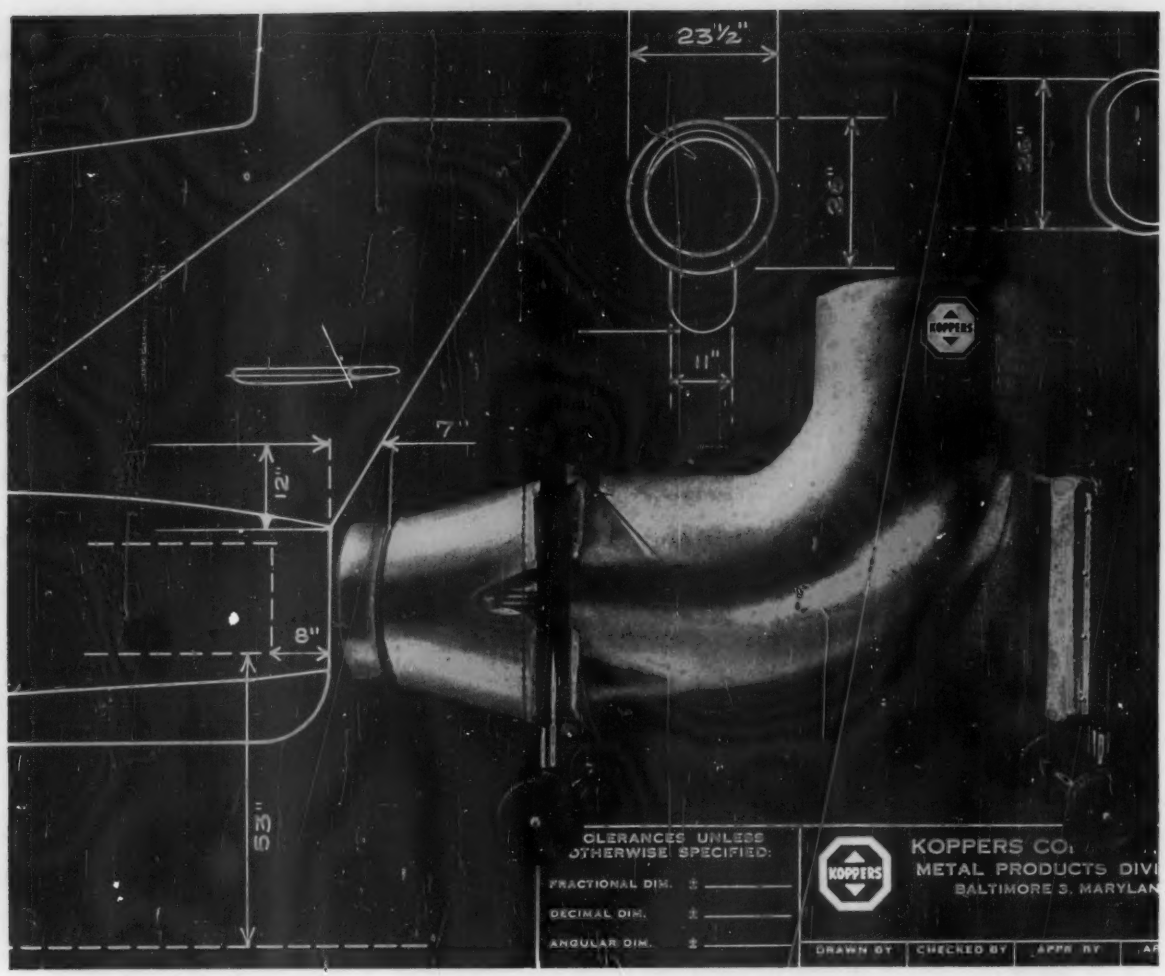
Jet Service Supports Soviet Airline Growth

Moscow—Aeroflot, Soviet state-owned airline, increased its passenger traffic by 42% during the first half of 1959, according to deputy chief V. Bashkirov.

The Soviet carrier attributed its gains in large measure to the introduction of 100-passenger twin-turbojet Tu-104 transports and 80-passenger four-engine Il-18 turboprop transports into scheduled service last April. New 85-seat four-engine An-10 turboprop transports will not have an impact on Aeroflot's passenger traffic until the latter half of the year.

Despite the healthy traffic increase, Aeroflot's system-wide gain in terms of additional passengers flown as compared with the first-half of 1958 is well below that of the U. S. transport industry. It is estimated that a 42% gain for all of 1959 would represent less than 3.4 million more customers for Aeroflot, where a 10% gain for U. S. carriers would mean nearly 5 million additional passengers.

Significantly, even the large percentage gains that Aeroflot has been reporting in recent years are beginning to taper off. In 1957, the Soviets announced a 69% traffic increase over 1956. Last year, the gain was 56%, and it now appears that this year's percentage increase will drop further.



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Trunklines, Cargo Lines Split On Cargo Transport Loan Proposal

Washington — Civil Aeronautics Board proposal to guarantee loans for the purchase of new turbine-powered cargo planes has touched off a verbal battle between major trunk carriers, who contend the plan is both premature and unnecessary, and smaller operators and all-cargo carriers, who view the proposal as a must for continued air cargo growth.

An informal meeting between the Board and the airlines last week brought no change in the conflicting opinions first expressed by the carriers in answer to an August CAB letter which expressed the Board's disappointment in air cargo growth. CAB asked the airlines' views on the value of a guaranteed loan program as an aid to re-equipping the airlines with new turbine-powered cargo aircraft which are expected to reduce ton mile costs and shipping rates, and thus increase cargo traffic potential.

Most outspoken objections to the plan came from American Airlines, Eastern Air Lines, Trans World Airlines and United Air Lines. All of them questioned the wisdom of a guaranteed loan program for purchase of an airplane not yet developed and they said that when a turbine cargo aircraft is produced, they are confident of obtaining their own financing and see little need for a guaranteed loan program.

American President C. R. Smith told the Board much of the airline industry feels the "cart is before the horse," since "we are talking about the financing of a plane that can't be built until a suitable powerplant is ready." While the industry is waiting for such a plane, he said, key to the entire issue is a lack of funds for research and development at the design level, and "not airline purchase funds."

"In my opinion, no case has been made for a program of government guaranteed loans for the acquisition of a new cargo plane," Smith said, "and we believe such a loan program should not be authorized until better justified."

Reason that a more suitable cargo plane has not yet been developed, Smith said, is that manufacturers are unlikely to design and produce a new aircraft unless they have some assurance it can be sold in enough volume to recover costs and produce a profit. Therefore, the actual production of the plane has little to do with airline financing, with or without government backing, he told CAB. Also, the profit ability of the aircraft will not be altered by the existence of a government loan, and the airlines will still have to repay the borrowed funds.

Even if a new type cargo plane is developed, manufacturers will still be faced with the problem of convincing potential customers that the aircraft can be operated at a profit. If the experience of early purchasers shows that the plane meets its projected operating estimates, private financing should be readily available, Smith said.

Eastern was even more dubious about the advent of a new type cargo plane, saying that "there hasn't been and we don't see in the immediate future a cargo aircraft which will be able to successfully compete with highly efficient truck and trailer combinations."

Agreeing that such an aircraft is needed, the airline said it could handle its own financing and suggested a continuing modification of presently depreciated larger passenger aircraft as the most logical approach to the problem at this time. Eastern said that its route system is more suited to operation of a turboprop cargo plane, such as the Lockheed Super Hercules than a turbojet.

United told CAB that its cargo airlift capacity will increase 75% when the carrier acquires its full jet fleet of 40 Douglas DC-8s and 18 Boeing 720s and is operating 13 piston engine cargo planes. The company said that while it has examined the plans of many manufacturers for a cargo aircraft, it has found "many discrepancies" in forecasts and costs compiled by the aircraft companies. United said that it has no need for a loan program but would not object to any legislation to aid interested carriers.

Trans World said that while it would support the loan legislation, a much stronger stimulus to the development of a new cargo plane would be afforded by government adoption of a policy to move as much government traffic as possible on civil carriers and to introduce an "all up" mail program using air transport wherever it will expedite delivery. Such action would tend to accelerate the current rate of air cargo growth and create a need for a greater number of the new aircraft, the airline said.

All-cargo carriers—AAXICO, Slick Airways and Riddle Airlines—told the Board the proposed loan program is essential to their efforts to acquire a more suitable aircraft, particularly since the carriers have neither subsidy eligibility nor permanent certification.

Flying Tiger line, which recently announced the purchase of 10 CL-44D cargo planes (see p. 38), feels the CAB plan may be just another form of subsidy. "If so, Flying Tiger wants none of it." The carrier told CAB that at best, the loan program could finance only a fraction of the aircraft needed and that adoption of the proposal might pose a serious "two pronged threat."

Flying Tiger said the result might be that "subsidy will build on subsidy" and asked the Board: "If the government guarantees the purchase of aircraft, will it also guarantee their profitable use to get the government 'off the hook' of purchase guarantees?"

Northeast Airlines commented that while it considered the CAB plan a fine idea, the airline had a ton mile load factor of less than 42% for the first six months of 1959, and therefore has plenty of unused space to fill before launching a re-equipment program.

Transcontinental S.A. To Buy Britannias

Buenos Aires—Privately-owned Transcontinental S. A. has won Argentine government support for its purchase of two Bristol Britannia 305s, scheduled for October and November delivery to the Argentine airline.

The Argentine Industrial Bank will guarantee up to $3.3 million of the $6.6 million turboprop order at 5½% annual interest. In a decree signed Aug. 14 by Argentine President Arturo Frondizi, the government announced that it is "the policy of the national executive power to foster the development of private enterprise in the field of commercial aviation."

Transcontinental is the strongest of several private airlines to emerge in Argentina since the deposition of the Peron government (AW Oct. 6, 1958, p. 38).

The Britannia service is scheduled to begin on Transcontinental's Buenos Aires-New York run next month. The route is now served with Lockheed Super H Constellations.

With government-owned Aerolineas Argentinas now operating the Comet 4 to New York, both Argentine carriers will be using British turbine equipment on the run next month. A Transcontinental spokesman attributed this situation to the lack of financial facilities in Argentina to purchase equipment from American manufacturers, whose credit offers, he said, are considerably less attractive than those of the British.

Bristol is financing the Britannia purchase over a five-year period, the spokesman said.

Transcontinental has ordered four Convair 600 jet transports with delivery scheduled in 1961. This order has not been affected by the Britannia purchase, the spokesman said. The airline had originally ordered the 880 model of the Convair jet.

Braniff's new fleet of Lockheed Electras, now in operation, will be augmented next December, by Boeing 707 jet liners—both using Texaco Aircraft Turbine Fuel.

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Idlewild Jet Noise Complaints Increase

By Glenn Garrison

New York—Aircraft noise complaints from New York International Airport neighbors having been running heavy, as expected, since the advent of the summer "open window" season and the increased frequencies of jet transport operations (AW June 22, p. 100).

The Port of New York Authority received 113 complaints last month concerning Idlewild operations, including 65 complaints about jet noise specifically. The figures do not reveal the fact that some of the complaints are petitions signed by tens or hundreds of people. Also included are complaints from elective officials who represent local constituencies.

In July, 1958, the Port Authority received two noise complaints, according to the agency's figures. There were 34 in June, 1959, none in June, 1958.

National Air Transport Coordinating Committee, local anti-noise agency operated by the industry, received 616 complaints in July and 510 during the first 25 days of August covering Idlewild operations. Of the August total, 142 concerned jet operations. The July total for Idlewild and LaGuardia airports, including both jet and piston flights, was 1,226, according to NATCC, compared with 224 in July, 1958. The 1959 figure includes two petitions with over 100 names on each.

July Poor for Jets

As both agencies point out, July, 1959, was an unusually unfavorable month for jet operations for several reasons. Weather and wind conditions required a much greater than normal percentage of instrument landings, necessitating use of a poor runway from the noise standpoint; and construction of a new instrument runway and other runway work put the preferred runway out of action for various periods.

Jet operations were up, according to Port Authority figures, to 597 takeoffs during July, compared with 525 the preceding month.

In another of a series of letters to community leaders, dated Aug. 13, Port Authority Director of Aviation John R. Wiley again took American Airlines and Trans World Airlines to task for their jet procedures and gave Pan American, British Overseas Airways Corp. and Aerolineas Argentinas a pat on the back.

Reporting an over-all level of conformance with Port Authority jet takeoff rules of 70% for July, compared with 59% for June, Wiley went on to say:

"It is very distressing to all of us concerned with the jet noise problem to observe the continuing deplorable conformance records of American and Trans World Airlines. The sorry performance of these two airlines is cogent evidence of their unwillingness to accept their responsibility to solve the noise problem. Their records of conformance for July (American 63.3%, and TWA 59.6%), while showing an improvement over their June records, when each conformed on only 47.0% of their takeoffs, are still considerably below the record of 87.9% conformance for July of all other carriers. The records of Pan American World Airways, Aerolineas Argentinas and British Overseas Airways Corp. show that if the airlines are willing they can considerably reduce the jet noise problem. These three carriers should be commended for their public-spirited attitude."

NATCC Compliancy Record

On the other hand, NATCC said compliance with its new procedures, which became effective July 1 (AW June 29, p. 29), has been "almost 100%." This agency's standards do not include decibel maximums and do consider aircraft weight, fuel, cargo and passenger loads in determining takeoff runways. The Port Authority sets a maximum decibel standard and does not consider the other factors mentioned.

One of the community leaders recently protesting to the Port Authority about jet noise was John T. Clancy, Borough President of Queens, who appeared last week before a congressional committee examining jet problems in an executive meeting. Clancy recently blasted the Idlewild noise situation and Wiley, in a statement answering the borough president, acknowledged that "tolerable conditions do not exist at all times now and we are disappointed that American Airlines and TWA have not followed the procedures. . . ." Wiley noted runway extensions and other facilities improvements to make possible more tolerable conditions and added "I believe it would be premature at this time to suggest that the traveling public and air commerce accept the handicap of one-stop instead of nonstop service to the Coast or Europe . . . without first making every effort to see to it that the needs of commerce can be blended in with the rights of the airport neighbors."

NATCC includes representatives of the airlines, manufacturers, Federal Aviation Agency, and other industry segments and, until a few months ago, the Port Authority. It has since 1952 had in effect a preferential runway system for piston planes, and the new system is designed to cover both piston and jet-powered aircraft.

MacIntyre Will Head Eastern

New York—Eastern Air Lines' top management will be realigned on Oct. 1 when Board Chairman Capt. E. V. Rickenbacker steps down as chief executive officer and Malcolm A. MacIntyre assumes the position of president of the airline.

Thomas F. Armstrong, now president of Eastern, will fill the new post of executive vice president.

Rickenbacker, who has managed Eastern since 1934, will continue as board chairman and will head a new seven-man executive committee dealing with major policy. He also will head, at least initially, the carrier's operations committee.

The moves are designed, Rickenbacker said, to provide specialized management of economic, financial and technical problems and to enable him to devote more time to policy matters and long-range planning.

Armstrong, the airline said, will devote his full time to fiscal matters. Constant air travel in connection with his six-year tenure as president has aggravated a spine injury and forced him to restrict his travel activities, according to the airline.

MacIntyre resigned last July as Under Secretary of the U. S. Air Force. He has been named a director and chief executive officer as well as president of Eastern.

MALCOLM A. MacINTYRE

LOWER OPER

1300 HOURS BETWEEN OVERHAULS FOR ROLLS-ROYCE AVON TURBO JET

DE HAVILLAND COMET

SUD AVIATION CARAVELLE

On July 3rd, 1959 the British Air Registration Board approved an extension of overhaul life of the Avon RA.29 to 1300 hours. The Avon entered commercial service on the North Atlantic route with British Overseas Airways Corporation on October 4th, 1958 at an overhaul life of 1000 hours.

Approval has also been given for trials at 1600 hours between overhauls.

During overhaul life, no scheduled engine unit changes are made apart from the fuel filter element and no internal inspection of the engine is necessary.

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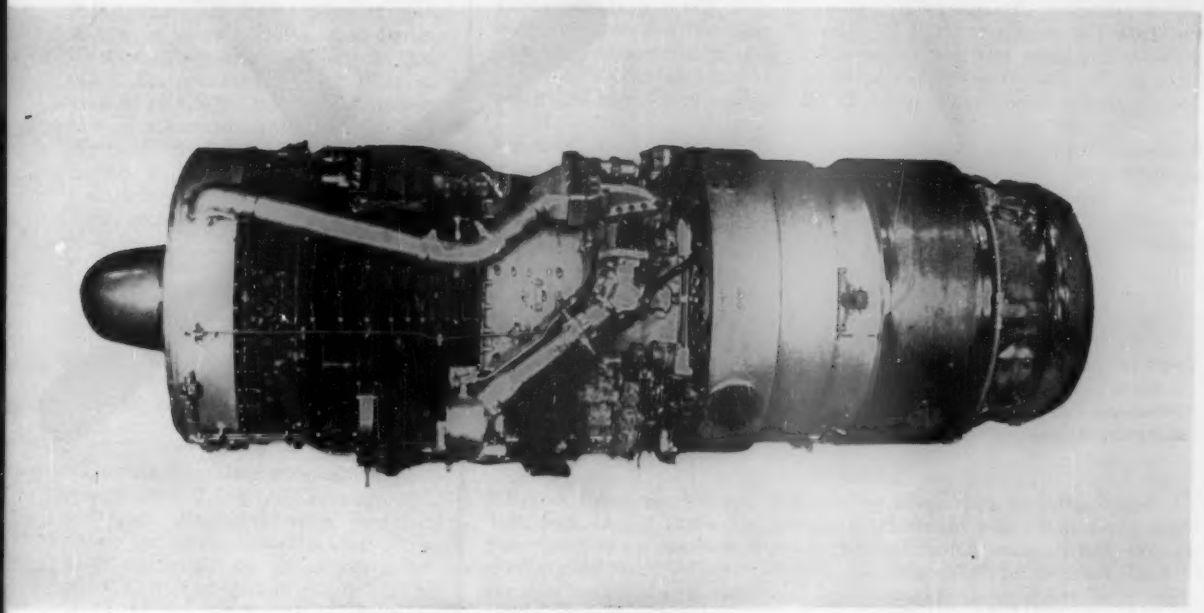

4 MAN-MINUTES PER FLYING HOUR FOR ALL AVON MAINTENANCE

This figure includes the installation of the engine and its removal from the aircraft.

ONE UNSCHEDULED OVERHAUL IN 49,000 ENGINE HOURS

During the first nine months of Comet operation by B.O.A.C. only four engines were removed in 49,000 hours flying for causes considered to be Rolls-Royce responsibility. Only one of these required overhaul, the other three being rectified and returned to service.

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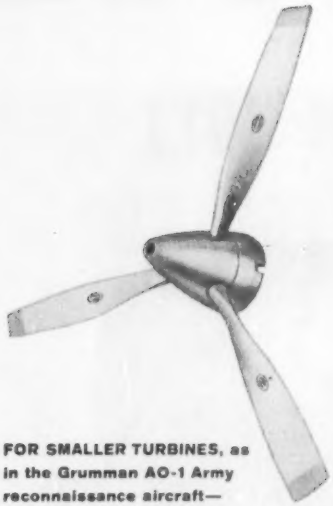
Aerolineas Argentinas, British European Airways, British Overseas Airways Corporation and East African Airways in de Havilland Comets; and Air Algerie, Air France, Finnair, Royal Air Maroc, Scandinavian Airlines System, Swissair and Varig in Sud Aviation Caravelles.



FOR SMALLER TURBINES, as in the Grumman AO-1 Army reconnaissance aircraft—the 53C51 Hydromatic

FOR LARGER TURBINES, as in the Lockheed Electra airliner and the C-130B military transport—the 54H60 Hydromatic

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SHORTLINES

► **Air Jordan** is scheduled to begin service between Amman, Jordan, and Rome with a flag stop at Jerusalem in October to connect with Pan American World Airways Boeing 707 flights to and from the U.S.

► **Bulgarian government** plans to open a new air route between East Berlin, Warsaw, Prague and Varna on the Black Sea sometime during 1960 according to a Sofia broadcast. Construction of a new airport capable of handling all types of aircraft including Soviet Tu-104 turbojet and Tu-114 turboprop transports will begin in early 1960, according to the broadcast.

► **Guest Airways** of Mexico has been awarded permanent traffic rights into Bermuda on its flights from Mexico City and Miami to Lisbon, Madrid and Paris. Previously, approval had to be received in advance for each passenger boarding or leaving a Guest flight in Bermuda.

► **Los Angeles International Airport** reports that 2,644,920 inbound and outbound passengers were handled during the first six months of 1959, a 34.4% increase over the same period of 1958. Freight volume was up 12.9% at 48,187,198 lb.; express, 12,869,453 lb., up 20%; air mail, 21,679,585 lb., up 14.5%.

► **Northwest Airlines** reports a net income after taxes of $738,722, for July, a 14% decline from the July, 1958, figure. Operating revenues for July of this year were $11,552,739, up 18.8% over last year. Operating expenses for the month were up 21.1% at $10,006,266. Northwest is scheduled tomorrow to increase air freight flights to the Orient from New York from two to five per week.

► **Ozark Air Lines** reported a net profit of $87,958 for the fiscal year ending June 20 as compared with a loss of $128,706 for the previous fiscal year. The local-service carrier flew a total of 488,525 passengers during the fiscal year.

► **Piedmont Airlines** recorded $5,823,816 in operating revenues and $5,919,356 in operating expenses for a net loss of $95,540 during the first six months of 1959.

► **Portland International Airport** handled 482,610 inbound and outbound passengers during the first seven months of 1959. Through passengers at the Oregon airport numbered 205,699.

AIRLINE OBSERVER

► Current top contenders for the two Civil Aeronautics Board membership posts which will be open this year include Franklin M. Stone, CAB general counsel; George M. Moore, executive assistant to the Postmaster General; former Sen. Charles Potter of Michigan, Pat Hillings, former congressman from California. Vacancies will result from the expired term of Harmar Denny on Dec. 31 and nomination of Chairman James Durfee to the U.S. Court of Claims (AW Aug. 31, p. 25). Long-expected objection to the nomination by Sen. William Proxmire (D.-Wis.) was made last week one day before committee hearings on the nomination were scheduled to begin. Proxmire successfully caused the hearings to be postponed. Move could result in a recess appointment after Congress adjourns this month.

► **Federal Aviation Agency Administrator Elwood R. Quesada completed plans to train FAA flight operations inspectors aboard Air Force Strategic Air Command KC-135s (AW Aug. 31, p. 45) in approximately 10 min. Quesada side-stepped normal red-tape processes by personally calling on Gen. C. E. LeMay, USAF vice chief of staff, with the proposed jet training program. Agreement between the two was reached on the spot.**

► Lockheed contract with Pan American and Slick Airways covering the sale of 18 Super Hercules all-cargo turboprop aircraft is contingent upon the sale of a fleet of the military version of the aircraft to USAF by Sept. 30. If no military contract is completed by that date—and Defense Department Fiscal 1960 appropriations do not provide funds for logistics aircraft—both the manufacturer and the two airlines are entitled to withdraw from the contracts.

► **British European Airways' demands for lower fares at International Air Transport Assn.'s Traffic Conference in Honolulu will follow these lines: Fare structure on continental routes that will match economy fares now in effect on the North Atlantic. Greater fare differentials for different times of the day, week and year—the carrier wants a mid-week night fare 20% below current tourist fares, for example. Lower fares on "holiday routes" in April, May and early June as a means of extending summer peak travel over a longer period of time.**

► Russia is building a large new terminal at Vladivostok Airport to handle sharply-increased plane traffic which has swamped present facilities at the Far-Eastern city. Other large Siberian cities with major airport projects under way include Novosibirsk, Khabarovsk and Irkutsk. A third major airport for Moscow was recently completed (AW Aug. 31, p. 47).

► **Inter-island airline fight in Hawaii has been intensified by the sharp increase in passenger traffic experienced by Aloha Airline since it began service with three Fairchild F-27 turboprop transports in June. Hawaiian Airlines is conducting a wide-scale promotional campaign in a renewed attempt to push its fleet of five Convair 340s and hold its share of inter-island traffic.**

► British Overseas Airways' recent first regular around-the-world service flight ran into a 60-hr. delay at Honolulu due to an impeller failure which led to high turbine pipe temperatures on one of the Proteus turboprop engines powering the Bristol Britannia 312. Flight, which was en route to Tokyo from Honolulu, was forced to turn back because of the engine problem. Engine change was required, and spare engine was flown by Flying Tiger Line from San Francisco.

► **Studies are being conducted for the Federal Aviation Agency to determine whether fuel supply for Washington's Dulles International Airport now under construction should be handled by pipeline, tank-car or truck. Approximately one-half million gallons of fuel per day will be required when the airport is completed early in 1961, but the amount is expected to climb to two million gallons daily when it becomes fully operational. Studies are being carried out by the engineering firm of Ammann and Whitney.**

Airline Income & Expenses—June, 1959

(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income
DOMESTIC TRUNK								
American	32,104,634	574,835	294,360	1,941,578	.....	35,362,498	29,124,364	6,068,728
Braniff	5,084,572	128,774	58,733	185,377	13,214	5,561,482	4,997,316	510,775
Capital	9,156,717	171,405	102,704	125,157	13,500	9,713,553	9,165,309	548,224[2]
Continental	3,758,000	57,000	19,000	60,000	40,000	3,993,000	3,189,000	603,000
Delta	7,972,000	154,000	98,000	336,000	.....	8,738,000	8,140,000	566,000
Eastern	22,365,358	382,289	877,626[2]	.....	82,200	23,791,474	22,285,144	1,214,939
National	4,107,775	81,550	24,271	158,407	38,324	4,553,052	4,571,614	−58,522
Northeast	2,436,260	34,338	14,755	45,864	.....	2,588,838	2,986,101	−397,263[3]
Northwest	7,544,365	180,008	510,671[2]	.....	5,675	8,283,179	6,557,087	1,726,091[3]
Trans World	23,587,057	421,860	1,077,324[2]	.....	87,540	25,260,726	20,841,094	4,212,523
United	28,059,057	895,396	2,155,962[2]	.....	147,697	31,460,400	24,684,672	6,965,091
Western	4,665,912	92,154	32,000	110,058	11,341	4,971,199	3,918,819	984,206
INTERNATIONAL								
American	469,956	10,847	162	54,988	.....	562,323	544,447	13,371
Braniff	587,199	14,445	.....	44,645	.....	693,720	711,289	−25,270
Caribbean Atlantic	197,640	2,446	9,112[2]	.....	4,885	216,800	190,769	26,248
Delta	454,000	4,000	.....	18,000	.....	496,000	502,000	−8,000
Eastern	2,276,391	24,096	86,518[2]	.....	19,334	2,407,462	2,002,761	374,776
Mackey[1]	.....	.....	.....	.....	.....	.....	.....	.....
National	295,826	3,322	1,821	13,345	.....	324,949	334,286	−7,756
Northwest	2,730,825	562,537	425,163[2]	.....	.....	3,833,907	3,084,270	749,636
Pan American Combined	26,919,000	1,480,000	2,905,000[2]	.....	1,143,000	33,649,000	29,089,000	4,899,000
Alaska	381,000	21,000	44,000[2]	.....	1,000	468,000	466,000	2,000
Atlantic	14,310,000	703,000	1,060,000[2]	.....	291,000	16,793,000	13,040,000	4,158,000
Latin America	6,488,000	188,000	1,046,000[2]	.....	202,000	8,308,000	8,486,000	−183,000
Pacific	5,740,000	568,000	755,000[2]	.....	649,000	8,080,000	7,104,000	1,048,000
Panagra	1,060,000	40,000	.....	163,000	77,000	1,490,000	1,658,000	−186,000
Resort	.....	.....	.....	.....	633,430[4]	635,120	573,899	61,221[3]
Trans Caribbean	315,072	.....	37,028[2]	.....	19,481	440,321	425,595	18,773
Trans World	5,908,205	405,606	397,438[2]	.....	1,237,167	8,161,695	7,452,744	990,835
UMCA	3,467	.....	657[2]	.....	.....	4,136	10,209	−6,073
United	1,876,540	52,043	33,691[2]	.....	.....	1,973,690	1,288,656	674,996
Western	335,016	7,396	.....	3,299	.....	351,060	313,854	32,036
LOCAL SERVICE								
Allegheny	698,267	12,602	9,672	19,586	3,084[4]	979,719	931,044	48,675[3]
Bonanza	320,174	1,855	1,216	6,907	5,823	482,864	560,266	−90,641
Central[1]	.....	.....	.....	.....	.....	.....	.....	.....
Frontier[1]	.....	.....	.....	.....	.....	.....	.....	.....
Lake Central	234,075	4,434	7,608[2]	.....	5,355	398,582	355,822	42,761[3]
Mohawk	766,303	8,078	7,996	12,875	8,384	974,384	885,870	88,514[3]
North Central	1,157,223	25,250	20,000	9,554	22,782[4]	1,614,311	1,568,465	26,847
Ozark	702,606	260,583[5]	5,833	19,603	516	996,288	871,391	122,463
Pacific	495,916	13,123	6,529	−5	55,271	773,245	721,259	43,260
Piedmont[6]	705,689	10,460	5,792	9,750	11,402[4]	1,041,574	1,013,330	−1,545
Southern	287,989	8,862	3,777	9,028	1,765	509,007	478,356	28,228
Trans-Texas[1]	.....	.....	.....	.....	.....	.....	.....	.....
West Coast	350,437	4,592	1,382	5,983	5,018	991,110	627,124	363,986[3]
HAWAIIAN								
Aloha	335,513	1,779	.....	6,827	.....	356,680	304,165	52,515[3]
Hawaiian	527,857	3,113	.....	65,972	226,322	848,299	792,647	35,934
CARGO LINES								
AAXICO	.....	1,661	2,504	34,498	475,195	135,993	79,665	29,008[7]
Aerovias Sud Americana[1]	.....	.....	.....	.....	.....	.....	.....	.....
Flying Tiger	.....	13,477	1,245,310[2]	.....	1,747,703	3,011,868	2,807,654	242,618
Riddle	.....	.....	.....	783,492	.....	790,931	891,294	−100,363[3]
Seaboard & Western[1]	.....	.....	.....	.....	.....	.....	.....	.....
Slick	.....	.....	.....	.....	587,803	651,388	584,738	66,650[3]
HELICOPTER LINES								
Chicago Helicopter	118,993	146,854[5]	.....	.....	.....	270,229	193,646	74,205
Los Angeles Airways[1]	.....	.....	.....	.....	.....	.....	.....	.....
New York Airways[1]	.....	.....	.....	.....	.....	.....	.....	.....
ALASKA LINES								
Alaska Airlines	288,983	48,880	953	45,300	328,334	835,563	819,563	14,630
Alaska Coastal	115,200	8,065	.....	9,926	8,101	185,678	189,743	−12,376[3]
Cordova	15,458	10,065	.....	10,874	40,069	102,583	96,135	1,985
Ellis	65,100	5,100	10,000[2]	.....	5,900	113,500	104,800	8,700[3]
Northern Consolidated[1]	.....	.....	.....	.....	.....	.....	.....	.....
Pacific Northern	882,908	65,740	3,710	112,218	464	1,212,618	984,307	224,506
Reeve Aleutian[1]	.....	.....	.....	.....	.....	.....	.....	.....
Wien Alaska[1]	.....	.....	.....	.....	.....	.....	.....	.....

[1] Not available. [2] Property figure. [3] Net operating income. [4] Non-scheduled transportation. [5] Includes federal subsidy.
[6] Airline division figures. [7] Net income after taxes.
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

THE AIRLINES OF THE WORLD* HAVE ON ORDER MORE EDO LORAN EQUIPMENT THAN ALL OTHER LONG RANGE NAVIGATION SYSTEMS COMBINED • THE AIRLINES OF THE WORLD **HAVE ON ORDER** MORE EDO LORAN EQUIPMENT THAN ALL OTHER LONG RANGE NAVIGATION SYSTEMS COMBINED • THE AIRLINES OF THE WORLD HAVE ON ORDER **MORE EDO LORAN EQUIPMENT** THAN ALL OTHER LONG RANGE NAVIGATION SYSTEMS COMBINED • THE AIRLINES OF THE WORLD HAVE ON ORDER MORE EDO LORAN EQUIPMENT **THAN ALL OTHER** LONG RANGE NAVIGATION SYSTEMS COMBINED • THE AIRLINES OF THE WORLD HAVE ON ORDER MORE EDO LORAN EQUIPMENT THAN ALL OTHER **LONG RANGE NAVIGATION SYSTEMS COMBINED**

Edo

* 17, to date—Aerolineas Argentinas
- Air France • BOAC
- Canadian Pacific Airlines • Cubana
- Eastern Air Lines • Irish Air Lines
- Japan Air Lines • KLM
- Lufthansa • Northwest • Pan American
- Qantas • Sabena • SAS
- Swissair • Varig
- also in use by MATS

For complete data on Edo Model 345A Loran, send for **Technical Manual** *to Dept. 9-C.*

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The Allison Prop-Jet Super Convair Conversion is the best buy in the jet age—costs much less than comparable new aircraft. Yet, it meets any jet-age performance standards for short- and medium-range service.

Its cruise speeds are up to 345 mph or as much as 80 miles an hour faster than piston-powered Convairs. Its climb rate from sea level is tripled—over 2,000 feet per minute. It can operate from 4,000-foot runways with weights up to 48,000 lbs. Full pay load range is 675 statute miles—550 miles greater than piston-powered Convairs. Block speeds are increased 25% to 30%. Outperforms all types of Convairs available today.

MORE TIME AND COMFORT FOR EXECUTIVES—In corporate service, the Allison Prop-Jet Super Convair can be a real boon to business.

For instance, it can sharply cut executive travel time—give key company officers more time for business on important trips.

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Its noise and vibration levels are far lower than any piston-powered plane of comparable size—so executives get to their destinations fresher and more alert—are more rested when they return home. And pressurized cabins are available in arrangements to suit business needs.

Allison Unit Exchange Program for engines and propellers ends any delays for power plant overhauls.

MORE INCOME AND PROFIT FOR AIRLINES—Route analyses of several domestic airlines show this jet-age ship will yield a 19% to 48% return on invested capital.

That's based on load factors of 40% to 58%—varies depending on interior configurations and whether the lines convert Convairs they now own or buy used ones for conversion.

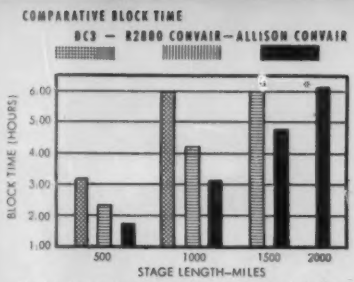
Normal seating capacity ranges up to 58 passengers—can be raised to 77 on particularly heavily-traveled short-segment routes.

There's extra passenger appeal in the high speed and low noise and vibration levels.

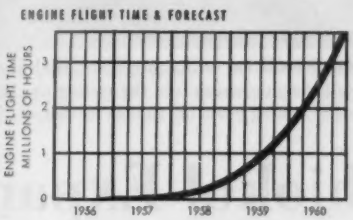
There's a big saving in capital investment over buying new aircraft when you get a Super Convair. Fewer Super Convairs can cover present routes—or airlines can cover

ALLISON

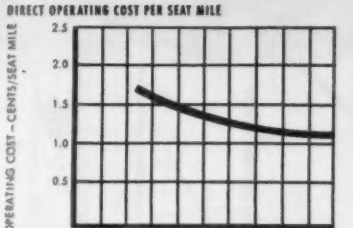
CHECK THE CHARTS... there's profit in Allison Prop-Jet Super Convairs



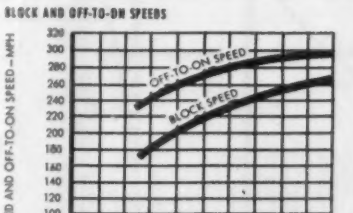
*With 2080 gallon fuel tankage (Standard tankage 1730 gallons)



Allison Prop-Jet Engines—Military and Commercial



Based on 56 seats



In-Flight Maneuvering Time: 3 Mins.
Ground Maneuvering Time: 5 Mins.

longer routes with the same number of planes used now.

And there's Allison's Unit Exchange Program for engines and propellers to save even more capital. It cuts required inventory in spare engines 80%, in line station parts stocks 90%, *and* eliminates procurement of overhaul parts stocks by the operator.

FOR ANY AIRCRAFT OPERATOR—The Allison Prop-Jet Super Convair is a real buy—and a proven ship. Its engines and Aeroproducts turbo-propellers have logged almost 1,500,000 hours of military and commercial flight time—its airframe has been in airline service for over seven years.

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Mr. William O. Watson, Manager, Sales & Contracts Dept. 5 B, Aircraft Engines Operations Allison Division General Motors Corporation, Indianapolis 6, Indiana

PROP-JET POWER

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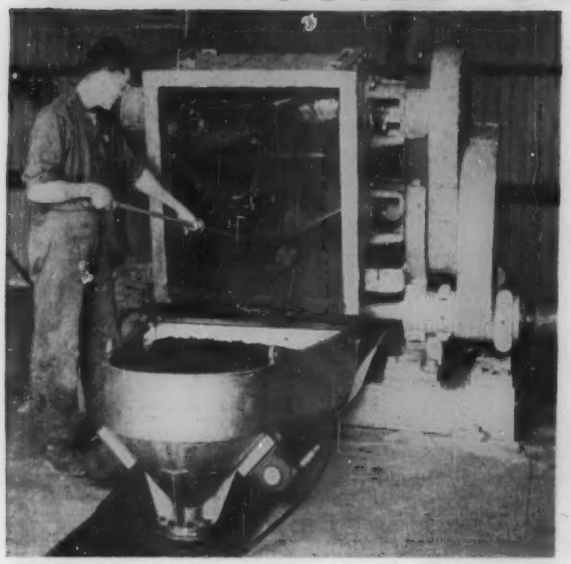
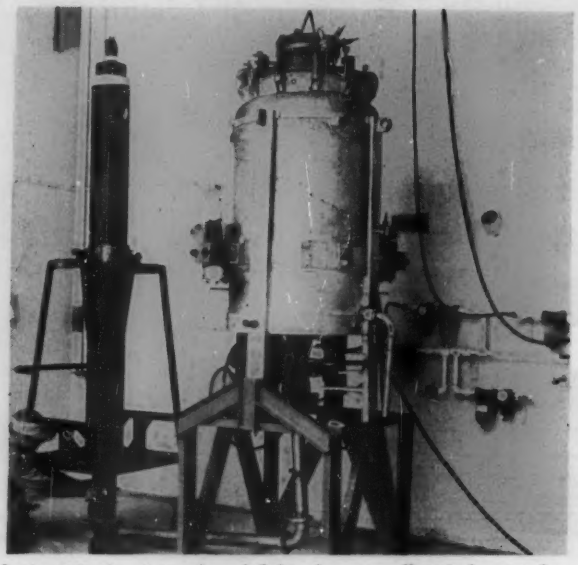
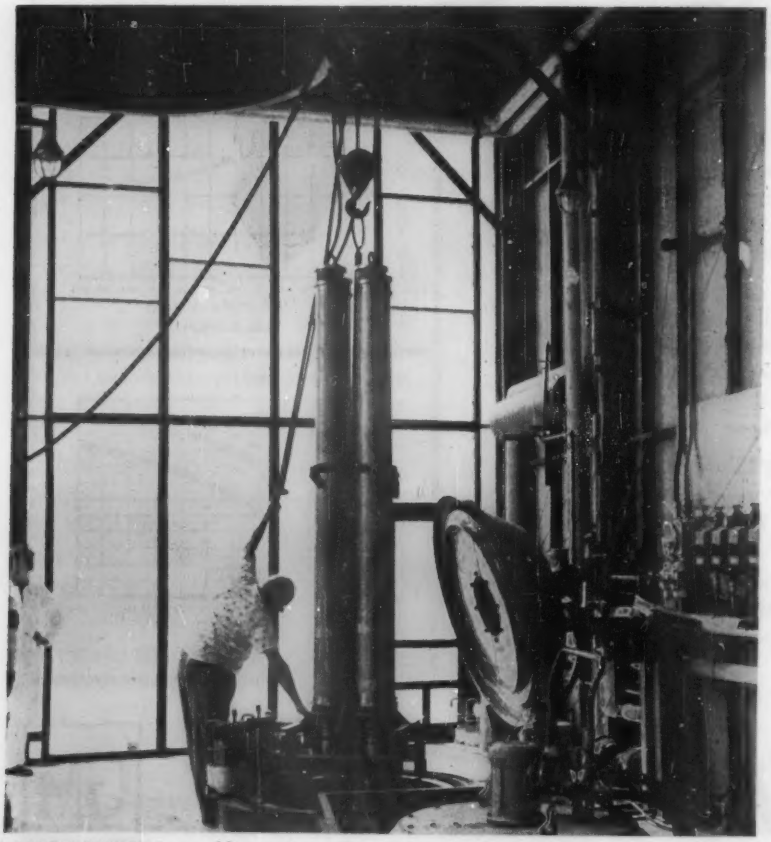




WORKER RAKES last of live propellant batch from blades of a 100-gal. horizontal mixer into a funnel (left) where propellant is de-aerated as it passes through a screen into the casting can below. In loading bay (right), worker attaches a loading bayonette from propellant can to bottom-fed casting assembly similar to that of the Apache. Air lines attached to loading can are used to pressurize propellant.

Thiokol Expands Quality Control System



LOADED CASTING assemblies are lowered, four at a time, into curing oven along with small ballistic test motors which are processed along with the full scale unit.

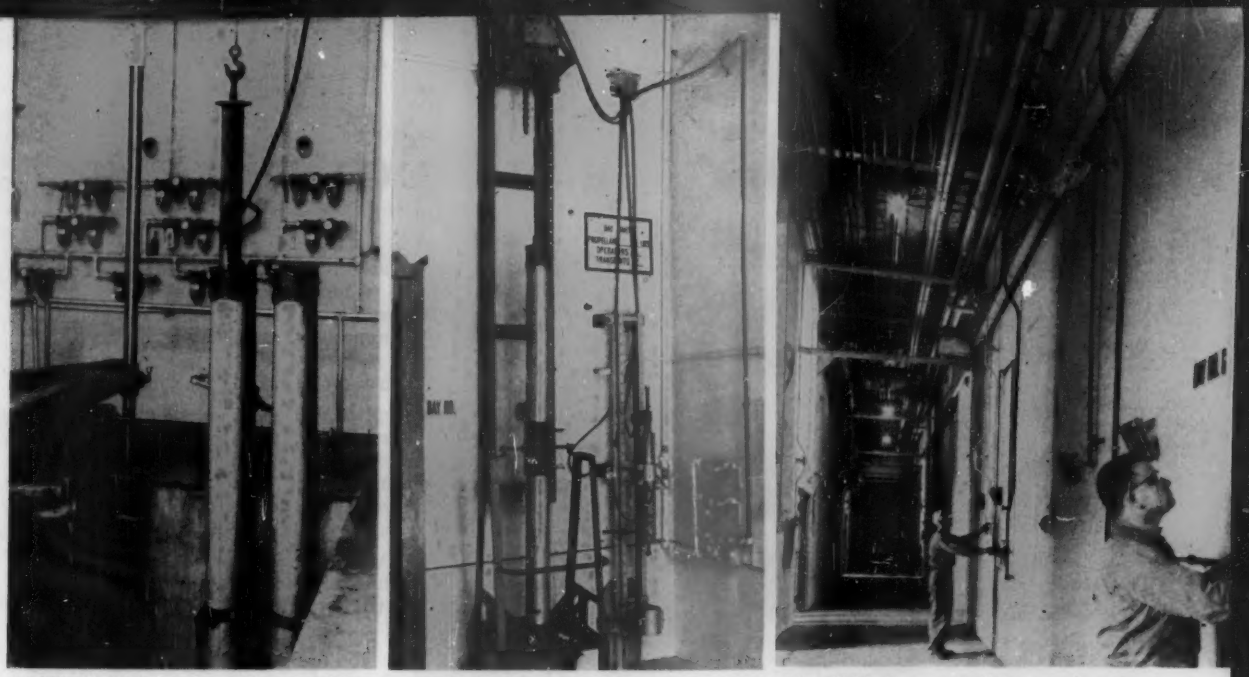
By Michael Yaffee

Elkton, Md.—More than 3,000 solid propellant rocket motors, made at the Thiokol Chemical Corp. plant here during the past 12 months, have been fired in the field without a failure. Reason for this high reliability, Thiokol says, is the company's new quality control program.

Real test of the program's effectiveness is expected to come in approximately two months when the company delivers the first of a number of new solid propellant rocket motors now being phased into production here. If the program is as effective as Thiokol believes, these new solid rocket motors will be the first to go into production with a virtual guarantee of 100% field operation reliability.

The plant here is Thiokol's own. Present production programs include the Cajun, Tart—a small countermeasures rocket (AW Aug. 24, p. 23); Falcon and Recruit solid propellant rocket engines. Among the new solid propellant programs now being phased into production at the Elkton plant are Apache, an improved Cajun; retrorockets, spherical rockets, Subroc and Yardbird (an improved Recruit).

Basically a Cajun with a higher energy solid propellant, the Apache is 108 in. long and has a 6.75 in. diameter. The first units, scheduled for delivery in about a month, will be used to power an advanced version of the Pogo-Hi



AFTER CURING Apache casting assemblies go into the finishing area. Here, again four at a time (left), they are held in a sunken thrust stand vise and the core fixtures are removed by remote control. On the wrenching machine (center), casting sleeves are removed; a blade is put on the machine and the excess propellant is trimmed off the ends of the motor casing. All operations at the Elkton plant involving live propellant ingredients are run remotely from behind barricades (right).

missile target developed by the New Mexico College of Agriculture and Mechanic Arts and called the Hi Ball. A look at the embryo Apache program shows the extent of the improved quality control procedures now in operation here.

First Step

At Elkton, production and quality control start with receipt of raw materials. In the production of solid propellant rocket engines, quality has to be built in from the start, explains Project Engineer Orville Reed; there's nothing that can be done after the parts or propellant are put into the engine.

All the raw materials purchased by Thiokol at Elkton are normally checked and certified to meet Thiokol specifications by the vendors before being sent to Elkton. Thiokol inspectors often go to vendors' plants to make sure that the vendors are using acceptable standards before they will certify them as supply sources. Sometimes, Thiokol actually sets up a quality control program at the vendor plant.

All raw materials arriving at Elkton are checked in through the receiving building. Here, the supply line divides, propellant materials going one way and hardware another. Thiokol inspectors check dimensions of metal parts and components and then send the parts to bonded stores until needed. No one is allowed to enter the storage area without proper authorization.

Propellant raw materials, after they are checked in through the receiving building, go directly to a laboratory where they are sampled and analyzed. Flammable materials, principally the oxidizers, are then stored in explosives-type magazines and the fuel binders and curing agents go into regular bonded stores.

When needed, the rocket motor case is removed from stores and thoroughly cleaned. Technicians visually check case surfaces for the presence of foreign particles and then cap or tape them to prevent contamination. In the case of Apache, the next step is preparation and application of the liner, which binds the propellant grain to the metal case. (In other solid propellant engines, liner and insulation are used between grain and case.)

Liner Process

To prepare the liner, production personnel obtain the liquid rubber polymer (which is basically the same material as the fuel binder itself), filler material and curing agent from inert storage, mix and pour them into the rocket casing. Inspectors carefully check the weights of the liner ingredients, the ingredients themselves, and the processing. The Apache casing is then rotated to distribute the liquid liner over the

AS A CHECK on motor quality, Thiokol will fire 3-5% of its full scale motors to verify qualify control effectiveness.

SPECIAL CRYOGENIC EQUIPMENT

High pressure—high capacity liquefied gas pump. Up to 90,000 scfh of liquid oxygen, nitrogen and other gases can be pumped to 15,000 psig, with no contamination. Built-in vaporizing equipment enables delivery of high pressure gas. Efficient and reliable, these units have gained wide acceptance by defense agencies and industry.

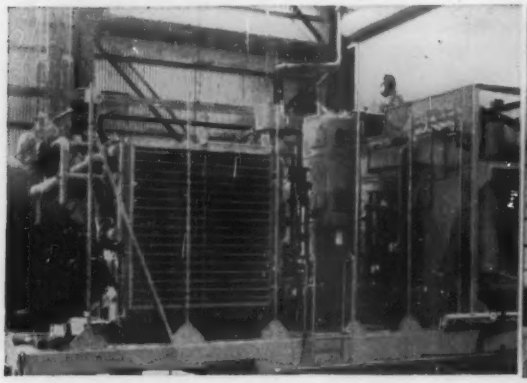
When you seek a proven solution to an unusual gas separation problem . . . when an entirely new low temperature process needs to be developed and made practical . . . when compactness and transportability demands are unusual . . . whatever your need for special cryogenic equipment, call on Air Products.

Air Products puts exceptional experience and skill at your command . . . a background of achievement that includes supplying a major portion of the cryogenic equipment for the defense program and, most recently, the first tonnage liquid hydrogen facility, engineered, installed and operated by Air Products for the U.S. Air Force.

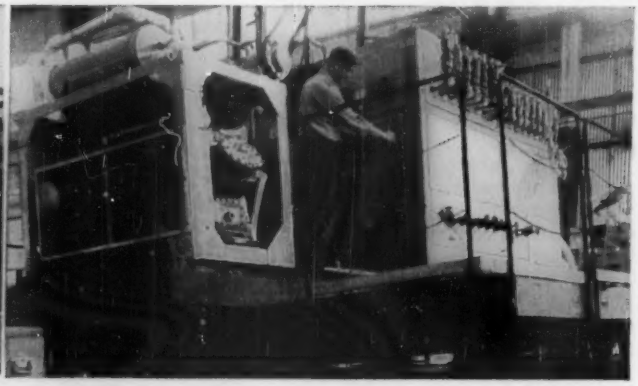
Air Products offers an unequalled range of services . . . including research, engineering, manufacturing and operation . . . and has the organization to service all equipment.

We will be glad to give you details on what we have done, and what we can do. Consult us about your cryogenic requirements, problems and ideas. Air Products, Inc., Allentown, Pa. Phone EXpress 5-3311.

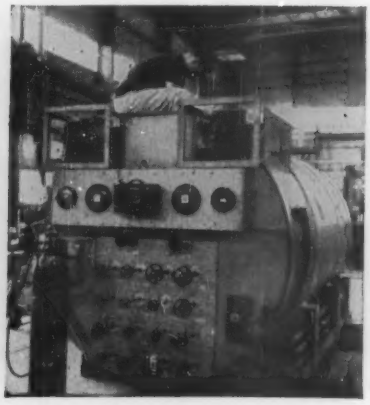
Some special equipment under construction at Air Products



High-capacity helium liquefier. This compact, semi-trailer mounted unit is also capable of liquefying hydrogen. Design of the process . . . requiring the extremely low temperature of minus 452°F . . . and construction of the heat exchangers, expansion engine, transfer lines and specially insulated compartments exemplify Air Products specialized cryogenic skills.



Shipboard liquid oxygen—liquid nitrogen generator. Air Products successful development of units like this was a major technological breakthrough in cryogenic equipment design. More than 40 are now aboard U.S. Navy vessels. This one . . . rated at 1.3 tons per day of high purity oxygen . . . is being tested on a special rig that duplicates the rolling and pitching motion of a ship.



Liquid oxygen—liquid nitrogen storage unit. Two separate tanks within a common outer shell can hold 750 gallons of LOX and 250 gallons of liquid nitrogen, with integral vaporizing equipment. This specially designed and constructed unit can withstand forces of up to 20 g's.

Air Products
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inside surface and then upended to increase the thickness of the coating at the hotter nozzle end. The lined cases are placed in a large oven where the curing agent, activated by the heat, links the short, liquid polymer molecules into long, solid polymer chains. Several small test motors which will be used to check the ballistic properties of the propellant are prepared in the same way and processed right along with the full scale engines.

After the casings are removed from the curing oven, casting sleeves are attached to the ends of the casings. These are short collars which permit an excess of propellant to be loaded into the casing and are used to bypass the difficult task of trying to load propellant to the exact point at which the case ends. The core fixture, which determines grain burning configuration, is inserted and fixed in place with two spiders (centering devices), one at the top and the other at the bottom of the case.

While this is going on, the propellant itself is being processed in another area. Under the close watch of inspectors, workers get the fuel binder polymer, curing agent and additives from storage, weigh and combine them to form the fuel premix. Principal additives are of two kinds: an energy additive, probably aluminum powder, used to raise the combustion temperature and specific impulse of the propellant; the other, a strengthening material used to improve the mechanical properties of the propellant grain.

Oxidizer Ground

Next, the solid oxidizer is taken from the storage magazine and placed in grinding machines. By remote control, workers grind the oxidizer into two particle sizes. The two sizes permit more oxidizer to be packed into a given volume, with the smaller particles fitting into the space formed by adjoining large particles. It is as if marbles were inserted in the little gaps left in a tube filled with baseballs. Samples of the ground oxidizer are sent to the control laboratory where technicians, using a Micromerograph and sieves, check particle size and distribution before releasing the oxidizer batch for use.

Fuel premix and oxidizer come together in a 100-gal. horizontal mixer and the propellant now becomes live. All mixing bays are located in an isolated area of the Elkton plant and are operated remotely from one master control room in the area. Each bay is separated from the next and from the control room by mounds of earth and a few hundred feet.

During the mixing, laboratory technicians run viscosity and density tests on the propellant and continually meas-

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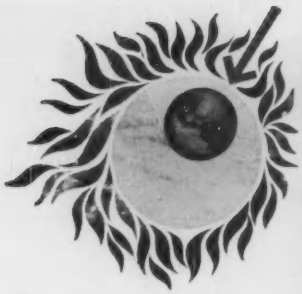

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IN X-RAY LABORATORY, another technician matches films against standard films taken previously to determine seriousness of density variations in propellant grains.

ure mix temperature, time and rate and over-all mix effectiveness. After the propellant batch is mixed, technicians take a sample of the uncured propellant to the control laboratory for immediate analysis. Although the curing agent is already in the fuel premix, it is not activated until the propellant is heated later in a curing oven. If final density and viscosity do not fall within specified limits, the batch is rejected.

If the propellant batch is approved by the control laboratory, it is trucked in casting cans to the loading area. Here, the casting can is pressurized with air and the propellant is fed through a bayonet loader, attached to the bottom of the casting can, into the bottom of the Apache casting assembly. Bottom loading is used in thin motors like the Apache to prevent air entrapment which would occur if the propellant were fed through the top into the very restricted flow area between the core fixture and casing. Several small scale test motors are also cast at this time.

Curing Phase

Apache casting assemblies are then transferred to a curing oven where, four at a time, they are subjected to a controlled temperature-time cycle curing along with the small ballistic test motors and sample of unencased propellant.

Activated by the heat, the curing agent, in effect, turns the liquid fuel polymer into the plastic fuel binder which holds all the solid propellent ingredients together in a fairly rigid grain. From time to time during the curing cycle, a sample of unencased propellant is removed from the oven and tested to determine the extent of cure. Afterwards, in the control laboratory, technicians cut up these little blocks of unencased propellant and run tests on the propellant's density, tensile strength and percentage of oxidizer. Acceptance of the propellant again turns on the results of these tests.

Spider Removal

When curing is complete, workers transfer the Apache casting assemblies from the oven by overhead monorail to the finishing area. Here they are placed —again four at a time—in a static thrust stand vise in a pit and production personnel, working remotely operated equipment from a barricaded control room, remove the core fixture and spiders.

Whenever metal rubs against live propellant, Reed said, the assumption is that the rocket is going to fire and it is treated accordingly.

The coreless casing then goes by monorail to a wrenching machine in another part of the finishing area. The machine, again under remote control, removes the casting sleeves and, after workers attach a blade to the wrenching unit, trims the excess propellant off

Air brake for a spaceliner

The earth's atmosphere, one of the biggest obstacles to getting into outer space, can be one of our biggest assets coming back. At Douglas we are investigating how we can use its braking effects on rockets returning from deep space trips at far faster than ICBM speeds. Success will allow us to increase payloads by reducing the weight of soft landing systems. This technique also will aid us in pinpointing landing areas. Current reports show real progress. Douglas is engaged in intensive research on every aspect of space planning, from environmental conditions on other planets to the destroyer-sized space ships necessary to get there. We invite qualified engineers and scientists to join us. Some of our immediate needs are listed in the column on the facing page. Please read it.

Arthur Shef, Chief, Advanced Design Section, Missiles and Space Systems, irons out a problem with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS

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both ends of the Apache casing which is simply rotated 180 deg. for the purpose.

Cores, centering spiders and casting sleeves are cleaned, inspected and returned to storage for later use.

After finishing, the Apache motors are wrapped in sheets of film and X-rayed as part of a complete radiographic inspection. In the X-ray laboratory, a highly trained technician carefully checks the films for light variations which would indicate variations in the density of the propellant grain. Most often, density variations are caused by the presence of entrapped air bubbles (less dense than the surrounding propellant, these show up as dark spots on the film) or foreign objects (generally more dense than the propellant, these appear as light spots on the film).

Locating Variation

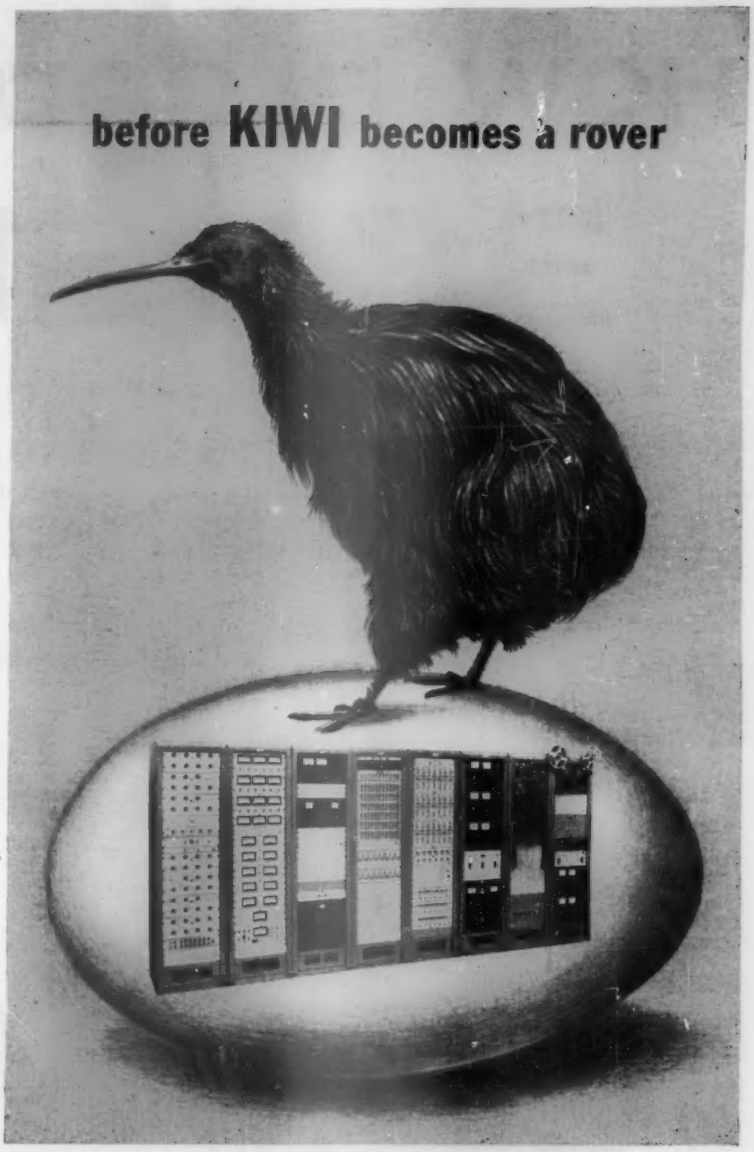
When a density variation does show up, the area in question is radiographed from different angles in order to pinpoint the true size and location of the variation. The technician then compares these films with standards (films of propellant grains with known defects which have already been fired and the results recorded) to determine whether the current grain defect will affect performance. If the indications are that it will, the motor is rejected.

At this point, the small ballistic test motors, which were separated from the full scale Apache units at the finishing area, will have been fired in the small static test cells at Elkton. Adjoining these small test stands are large test stands in which Thiokol will fire 3-5% of the full scale motors it produces. The full scale rocket firings will be used as a control on the quality control; that is, to make sure that there have been no slip-ups in any of the tests, that no errors have crept into the analyses and to ensure that the over-all quality control program is as effective as it was originally planned to be.

Results Checked

The results of these firings along with all in-process inspection reports, radiographic inspection reports and the laboratory analyses of the propellant's chemical and physical properties will now be carefully matched against specifications. If the results conform to specifications, the Apache engines will be placed in finished stores.

From finished stores, the engines go to final assembly. Here, Thiokol adds the components and subassemblies—namely, head cap, igniter and nozzle—required to complete the rocket motor. The finished Apache will then be given a final inspection, cleaned, painted and boxed. Instructions for field use are attached and the qualified rocket motors are shipped out.



Project Rover is aimed at developing a nuclear-powered rocket engine that will result in man's conquest of intergalactic space. Kiwi-A is its first land-based test reactor, named for the flightless New Zealand bird.

Before Kiwi becomes a space rover, an immense amount of test information will be needed. Edgerton, Germeshausen & Grier, Inc., is cooperating with the AEC, NASA and Los Alamos Scientific Laboratory in collection of this vital data.

For Project Rover, EG&G has designed, built and is now operating an 800-channel control and instrumentation system yielding diagnostic information for designers of tomorrow's spacecraft.

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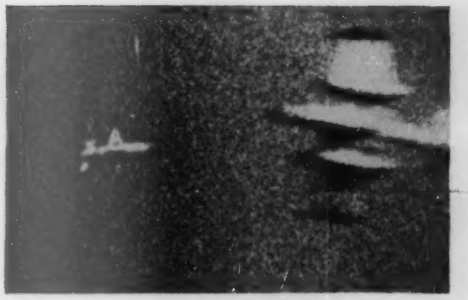

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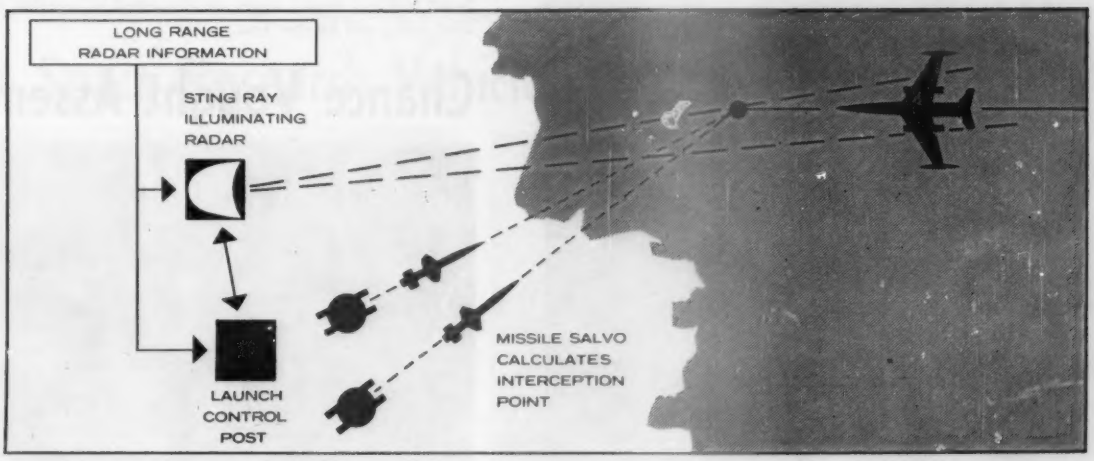

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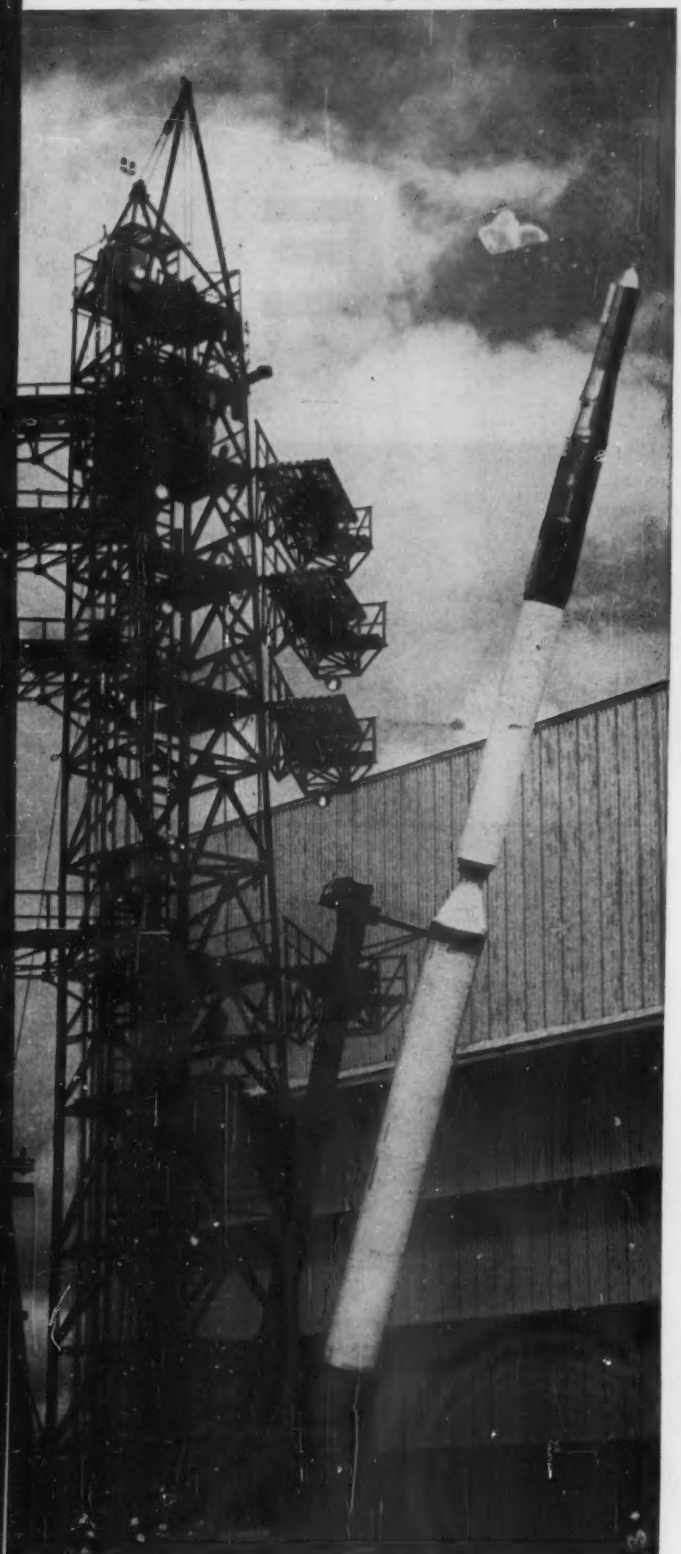
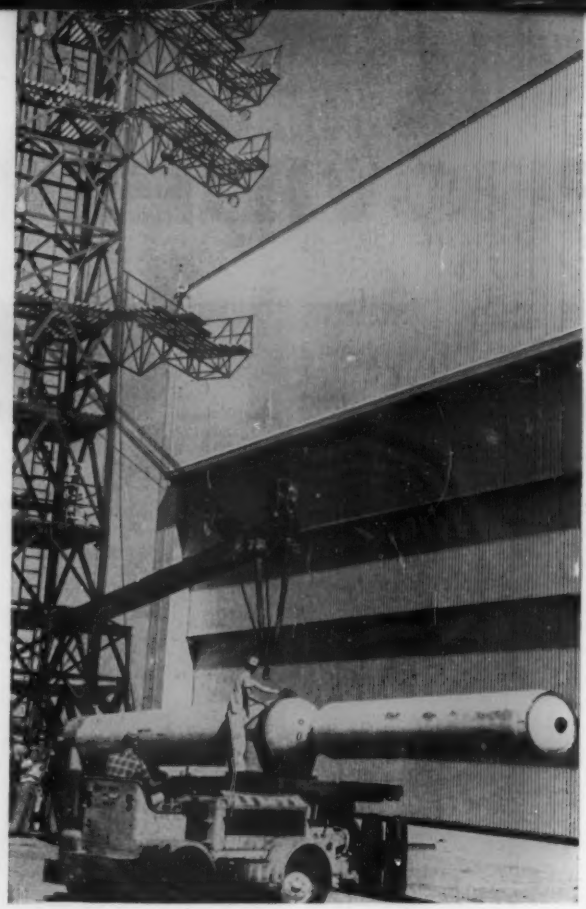


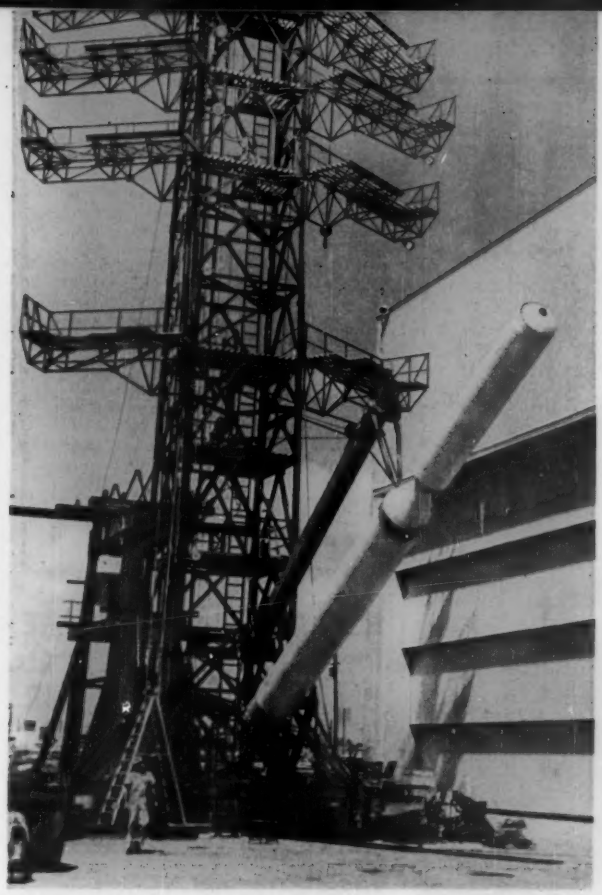
Scout space research vehicle is tilted 20 deg. from vertical at Chance Vought-built launch tower. Note work platforms swung out to provide firing clearance.

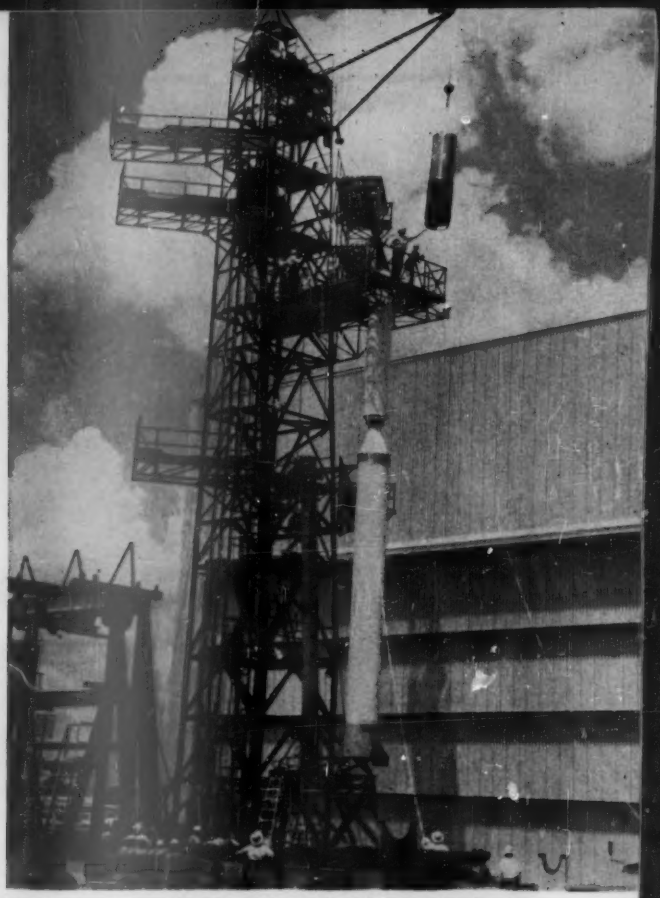


Scout first and second stages are connected to launcher beam. First firing will be this year.

Chance Vought Assembles

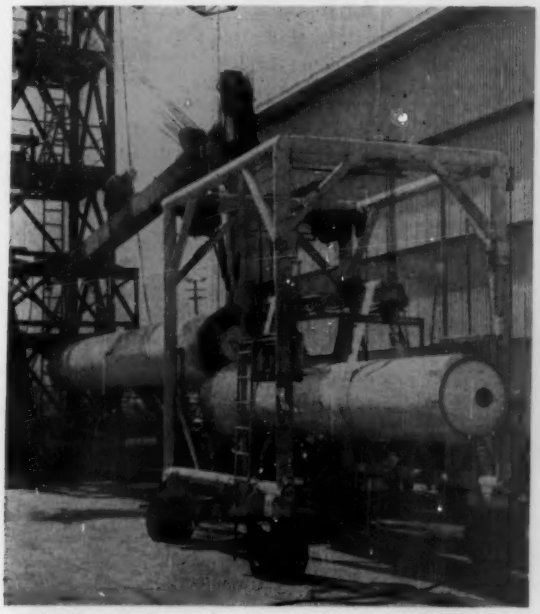
V-arm connection to top of second stage springs apart to permit Scout tail fins to clear launcher. Connection is pin and socket.

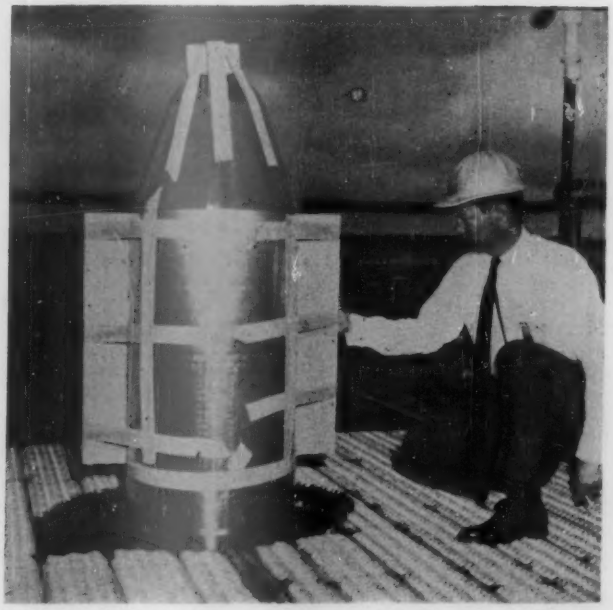




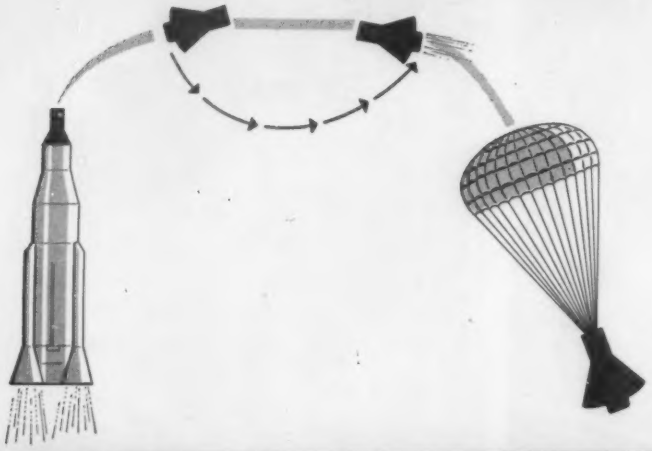
Stages are raised to tower in dry run (left). At right, third stage is raised for mating. Vehicle is built by Chance Vought for National Aeronautics and Space Administration and will be shipped to Wallops Island, Va. (AW Aug. 31, p. 31).

Scout Space Research Vehicle for NASA Firing





Aerojet-General Senior first stage (left) is assembled to the Thiokol second stage, an improved Sergeant. Fourth stage (right) contains payload; note balsa fins taped to steel heat shields to provide stabilization from wind blast while vehicle is in the launch tower. Heat shields are blown off by ballistic actuators after vehicle passes through atmosphere. Nose cone is nickel alloy.

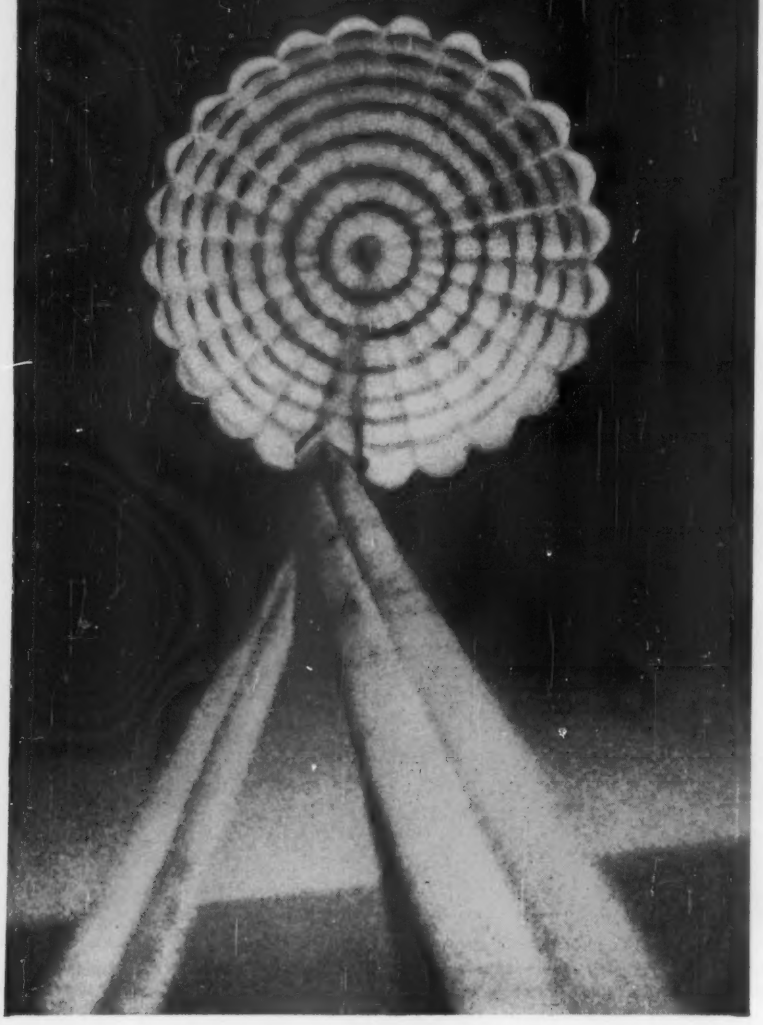


1. NASA flight plans call for ICBM-launching. The manned Mercury capsule will reach orbital velocity at about 120 miles, separate from the missile and ride horizontally in orbit.

2. Hurtling at 18,000 mph, the capsule will circle the earth in 90 minutes. Going into its re-entry phase, the capsule will be rotated by attitude controls to come "home" bottom down.

3. A drogue parachute will be deployed at 70,000 feet, decelerate the capsule and stabilize it. The final descent chute will be deployed at 10,000 feet preparatory for surface landing. Just prior to landing, pneumatic bags stored in the rim of the capsule will inflate to assure stability if landing is in water.

...NEWS IS HAPPENING AT NORTHROP



NEW TYPE OF RADIOPLANE PARACHUTE AN INTEGRAL PART OF NASA'S PLAN FOR RECOVERING FIRST MAN IN SPACE

The leader in the development, testing and manufacture of recovery systems – Radioplane–was selected by McDonnell Aircraft Corp. to join the National Aeronautics and Space Administration's Project Mercury.

Today Radioplane is readying the capsule landing system. For the project, Radioplane will use the new Ringsail parachute–a parachute with two radical departures from conventional Ringslot style. For a new kind of performance, Radioplane designed the new crescent-shape-slot parachute. The Ringsail withstands and reduces by as much as 35%, parachute opening shock at high-speed deployment. Drag coefficient and inherent stability are increased.

To solve the problem of aerodynamic heat without loss of strength, Radioplane is presently developing a high-temperature-tolerant fabric for drag devices.

This landing system for Project Mercury exemplifies Radioplane's unique capabilities. Scientists and engineers in Radioplane's Paradynamics Group combine their experience in the recovery field with the newest in equipment to develop systems with the highest degree of reliability. They are continually solving the increasingly complex recovery problems of the space age – producing the most efficient answers – at minimum cost.

RADIOPLANE

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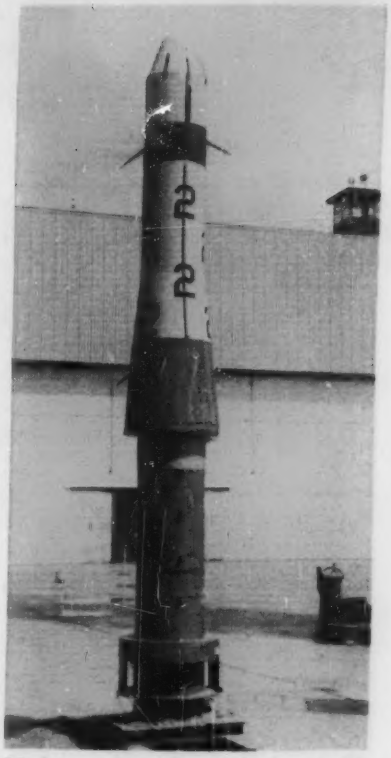
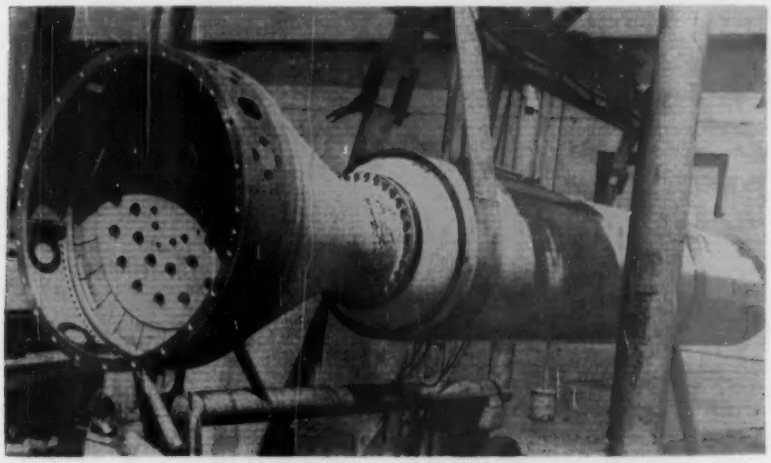
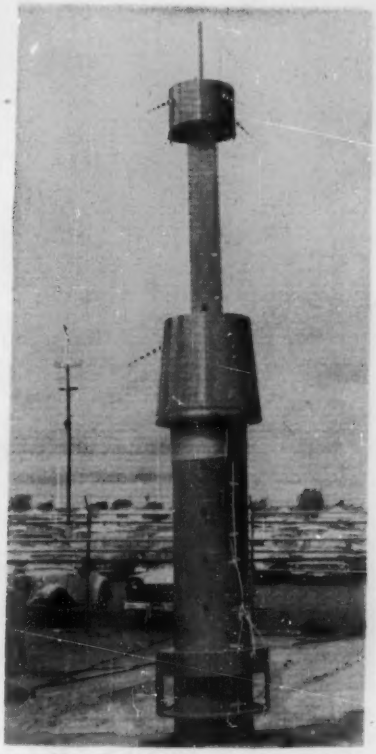
Aerojet-General Senior first stage is on dolly awaiting installation of tail fins, which provide initial stability after firing. Fins have movable tips which stabilize Scout after burnout of jet vanes. After fourth stage (Bureau of Ordnance-Allegany Ballistic Missile X-248, at right) separates, second and third stage stabilization is provided by reaction jets.



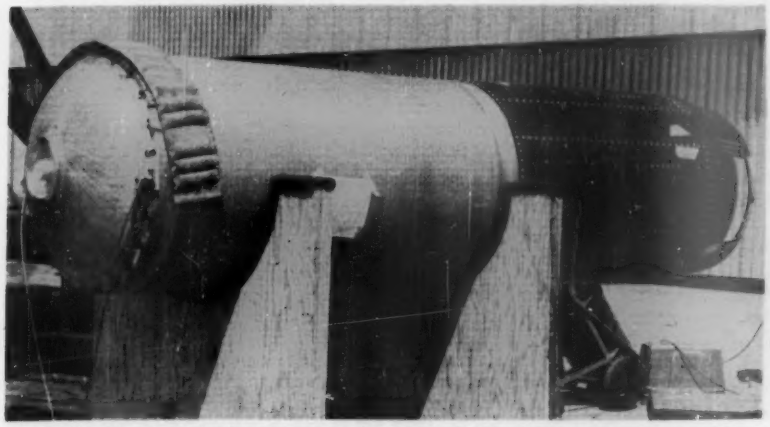
Mockup of Scout fourth stage is used to check out ejection features of the fairing.



Closeup of nozzle on Thiokol second stage, an improved Sergeant. This stage is bolted to first stage while both are horizontal; combination then is winched to vertical position and successive stages are lifted to tower by a hoist and then attached.



At proper altitude, fairing is blown away by small explosive charges, revealing payload.



Chance Vought Scout third stage, a BuOrd-Allegany X-254; light portion at left is Fiberglas and dark portion at right is magnesium construction. Scout was built in four months.

Growth Potential Defined for

By J. S. Butz, Jr.

Washington—Emphasis in design of re-entry vehicles is now centered around the dissimilar problems of improving the accuracy of nose cones for ballistic weapons plus the development of high efficiency heat shields for satellite re-entry capsules.

Flight tests in recent months have not only demonstrated that both heat sink and ablation nose cones will work for both types of vehicles but that present models have a substantial margin of safety that can be used to increase their performance.

In general, ablation heat shields have proven superior to the heat sink type. They have shown weight advantages of more than 40 to one in some cases over the heat-absorbing, non-melting sink design. Ablating type coverings will be used for the slim, densely-loaded second generation nose cones now being developed for Air Force ICBM and IRBM weapons by the General Electric Co.'s Missile and Space Vehicle Department and by the Avco Manufacturing Corp.

These second generation nose cones will be capable of re-entering the atmosphere much faster than the current blunt heat sink cones and probably will cut in half the time available for interception by an anti-missile missile. The more rapid re-entry also will greatly increase the accuracy of long-range ballistic rockets. The main design objective here is to reduce the error due to dispersion of the warhead atmospheric and aerodynamic forces to a point below the error of the guidance system. It is believed that currently known ablation materials will enable slender warheads to enter the atmosphere so rapidly that it will be 10 years before guidance systems can match their accuracy.

Ablation Shields

At present, there is one major question regarding ablation shields that may affect their use on some satellite re-entry vehicles. This is their ability to maintain their original shape and aerodynamic qualities as their surface is ablated away or, if this is impossible, to alter shape in a predictable manner.

The problem is of special interest for manned satellite vehicles which must re-enter the atmosphere at very small angles to keep deceleration within human tolerances. This requirement, in turn, determines that the vehicle will be subjected to much lower heating rates than the re-entering warhead, but the heating will continue for a longer period of time.

It has not yet been firmly established whether ablation shields will change shape during such a re-entry to a point where the drag of the vehicle, its landing accuracy and aerodynamic stability would be adversely affected.

Current research and development work on ablation nose cones is concentrated on providing materials that will hold their outer contour while providing maximum heat protection with minimum weight for a variety of tactical missions for both warheads and satellite re-entry vehicles.

Variable Drag Warheads

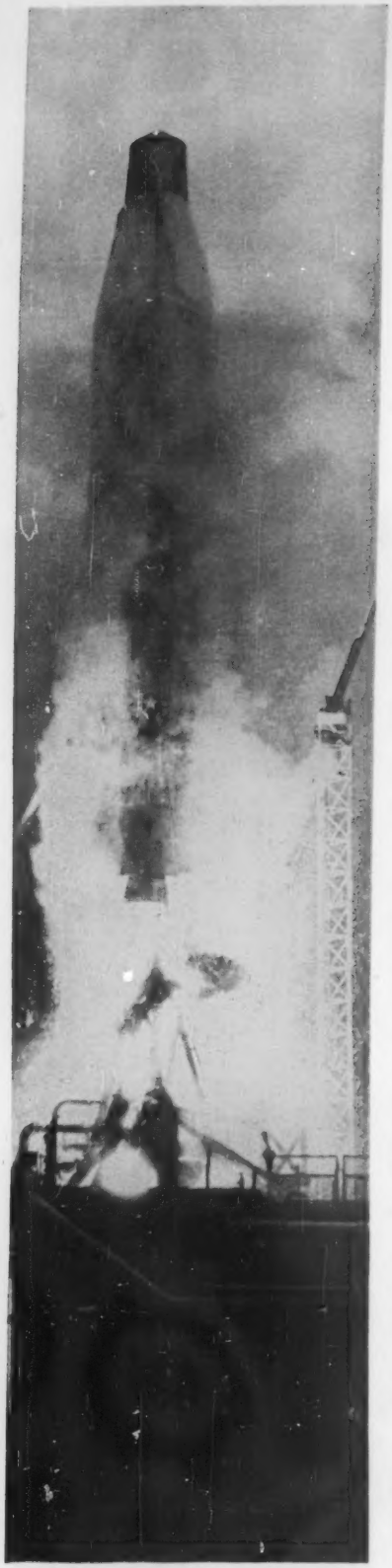
Tactical ideas for IRBM and ICBM weapon systems that have been discussed include the use of long narrow warheads with extendable skirts on their aft end so that they have a variable drag and are controllable to a limited degree. More sophisticated ideas involve warheads that pull out of their ballistic trajectory after they enter the atmosphere and glide into their target from a low altitude.

The general configuration of the second generation nose cones is ideal for this type of low altitude glide attack because it is one of the most efficient lifting shapes above Mach 4 or 5. Such a slender wingless nose cone is as good a high-speed flying machine as a winged aircraft.

If ablation shields can be developed that will hold their outer shape sufficiently for such glide vehicles to be controllable and accurate, then ablation-type heat protection also might be adapted to hypersonic orbital aircraft. This is the hope of many engineers today because of the light weight and gage of ablating material required to block very large total heat loads at high heating rates. Such design also would eliminate any weight or reliability problems with pumps, pipes and other components of cooling systems.

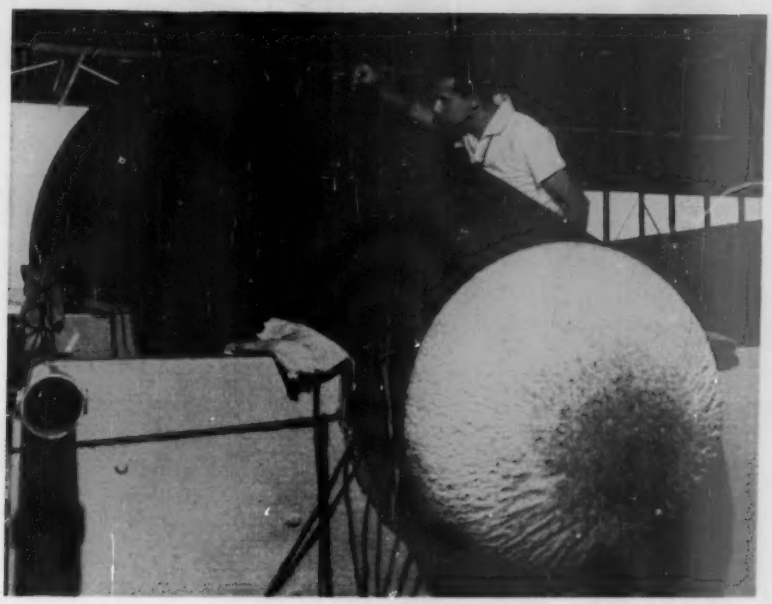
The uncertainty of the ablating pattern and the possibility of shape changes was one of the primary reasons the Air Force chose to pursue the heat sink rather than the ablation design for its first generation ballistic missile nose cones. It was decided in 1955 when the Atlas and Thor nose cones were contracted to General Electric's Missile and Space Vehicle Department to develop a blunt shaped copper heat-sink-type nose cone.

During this initial planning period it was felt that this vehicle would hold its shape exactly. The prediction was borne out in recent flight tests which showed that there was no melting or warping of the surface. In 1955, much more theoretical and experimental information was available concerning copper and the blunt design than that known

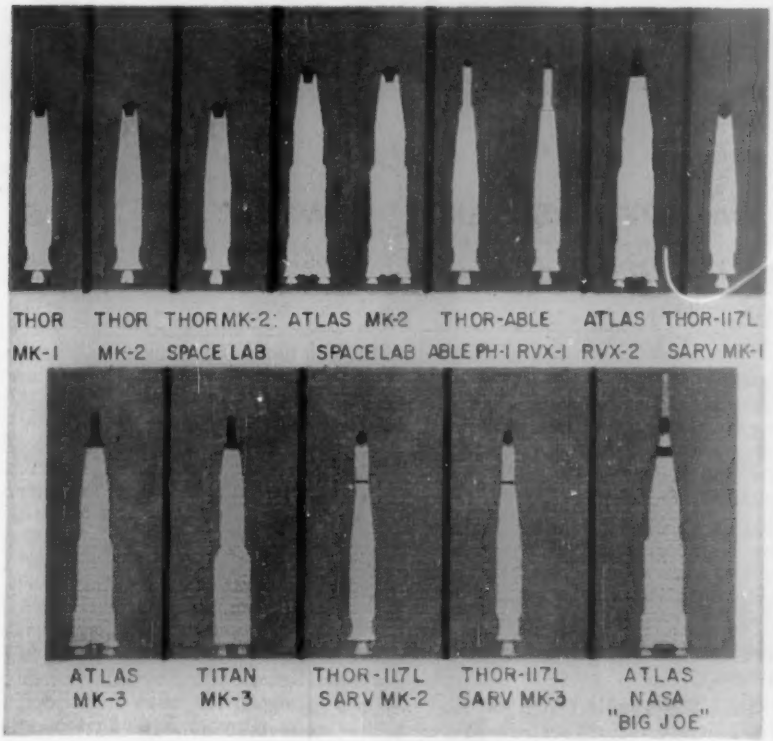


AIR FORCE—General Electric Mark II operational heat sink nose cone for ICBM and IRBM weapons is shown during Convair Atlas firing from Cape Canaveral, Fla.

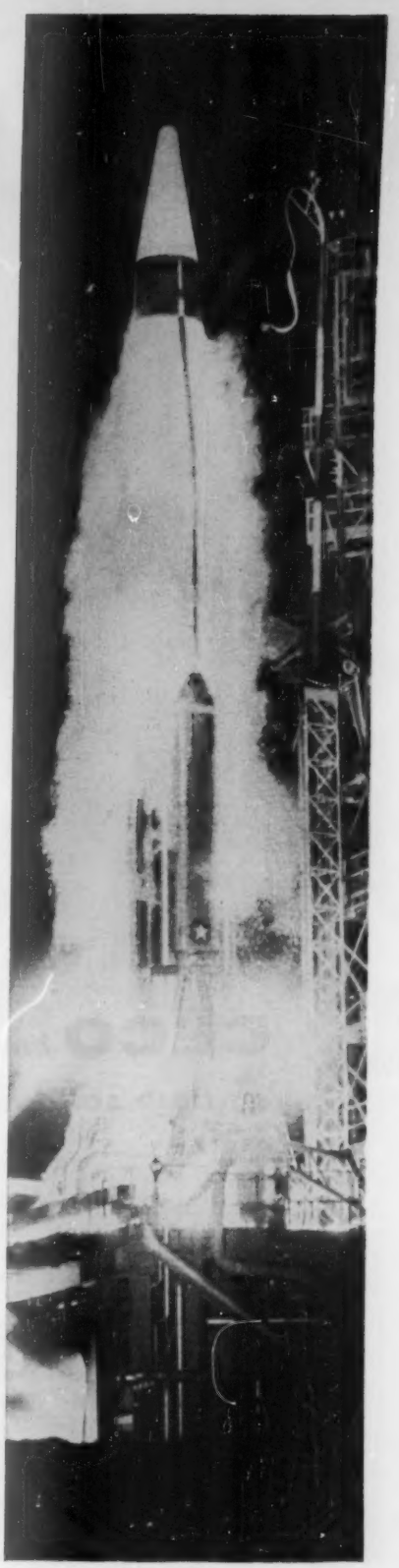
Heat Sink, Ablation Shields



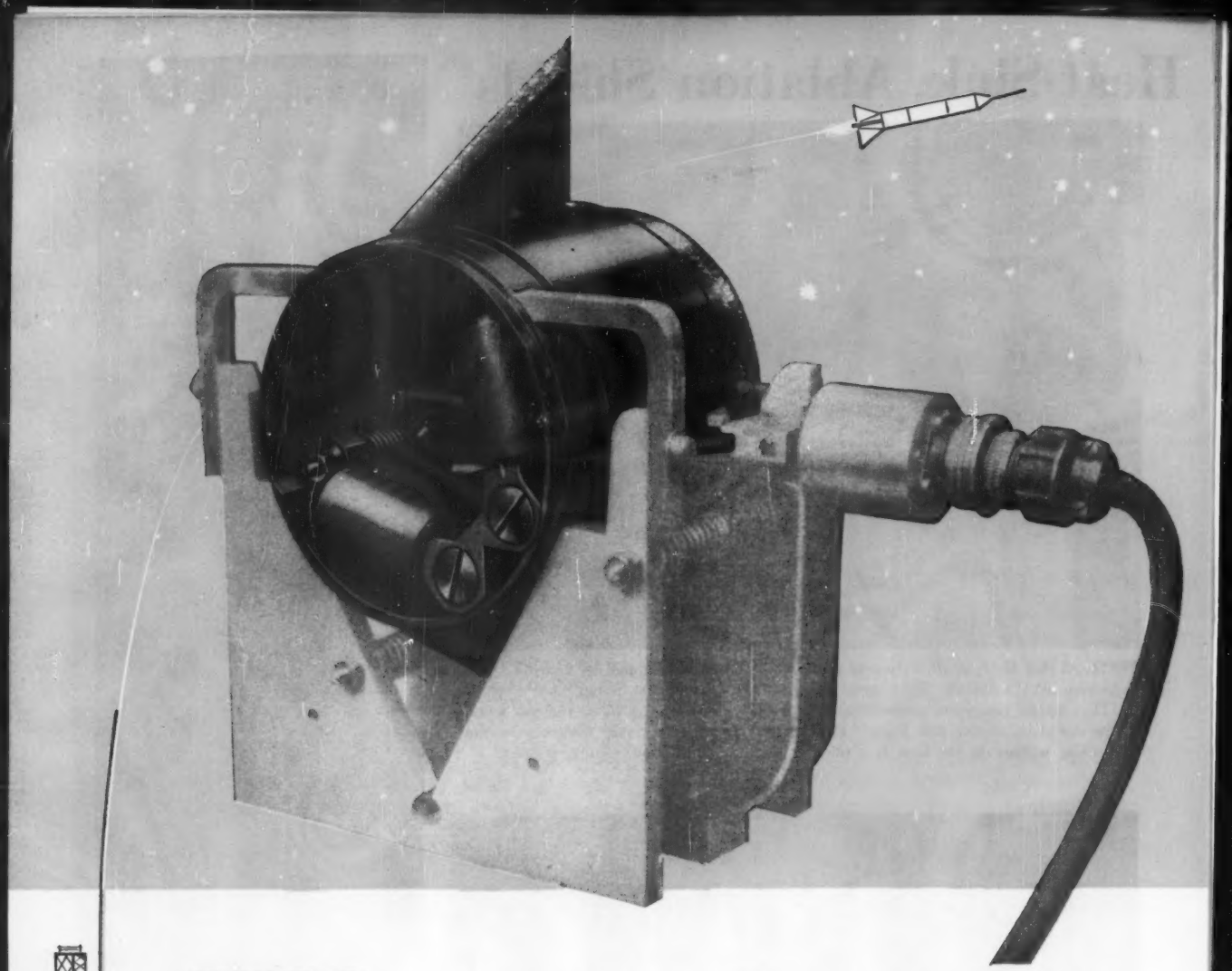
DEPTH of char layer on aft section of ablation nose cone is measured by General Electric technician after 6,300-mi. flight down the Atlantic Missile Test Range (AW Aug. 24, p. 121). Several composite materials which burn and char were tested on the rear sections of the nose cone during this flight. These included various phenolic resin compositions. The white section on the nose is a silicon substance which flows during re-entry.



RE-ENTRY VEHICLES designed by the General Electric Missile and Space Vehicle Department began with the Mark I and II heat sinks. Ablation testing has been done with the Able Phase I and RVX vehicles, leading to the Mark III operational cones now in design. SARV (Satellite Aeromedical Recovery Vehicles) are for Advanced Research Projects Agency.



TEST VEHICLE leading to operational ablation type nose cones, the General Electric RVX-2, is launched by Atlas missile over intercontinental ranges.



CECO has run HOT GAS SERVO CONTROL SYSTEMS on both solid and liquid propellants

Aided substantially by design and precision manufacturing experience in the field of highly sophisticated gas turbine control systems, Chandler Evans has been furthering the development of high-pressure pneumatic systems for missiles and satellites. Backed by highest technical and analytical skills, work on each new system includes thorough investigation in CECO's well-equipped Computer Laboratory.

Typical of progress made during the past several years is the new guidance control unit shown above in a test rig. A hot gas servo control system fueled by solid charge, it operates with gas inlet temperature in the 1800°F. range. Charge, control hardware and missile section—the entire system weighs only 6.9 lbs.

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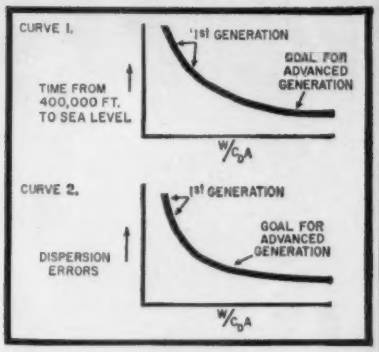


CURVES above show general nature of design problems for second generation warheads. Going to high values of W/C_DA can cut warhead descent time and error.

about other shapes and materials. This lack of detailed information was especially true of ablating materials.

Another factor in the selection of the heat sink design was the fact that the Air Force wanted the same nose cone used for both the IRBM and the ICBM. Heating rates are much higher for the longer range mission, and the possibility of an ablation cone changing shape and losing a great deal of its accuracy was a major consideration in 1955.

Ablation Flight Tests

Flight tests have since shown that ablation cones can enter rapidly at very high ballistic parameters. This parameter W/C_DA—where W is the total weight of the nose cone, C_D its drag coefficient and A the representative area used in the calculation of the drag coefficient—has a major affect on warhead accuracy. The higher the ballistic parameter, the faster the warhead will pass through the atmosphere and the more accurate it will be. The magnitude of operational ballistic parameters thought possible for ablating cones was much lower in 1955 than those proven possible by test today.

It has been planned almost from the beginning of the Air Force re-entry vehicle development program to use ablation materials in the second generation of nose cones because they offer the possibility of a tremendous reduction in the heat shield weight.

To obtain the detailed design data necessary to implement this plan, considerable effort has been devoted to the experimental and theoretical study of a wide variety of ablation materials and their behavior under every type of re-entry trajectory and condition.

Four general classes of materials have been of interest in this study:

- **Plastics which change** composition chemically as they are heated. As they change composition they also sublime and pass directly from the solid to the

AUGUST

27

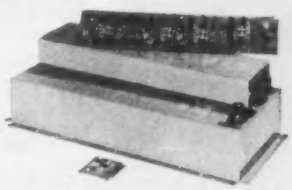
EECo meets crash schedule ...delivers electronic timing equipment in record time!

When electronic timing signal equipment was needed for the opening shoot on the Pacific Missile Range, Electronic Engineering Company of California was asked to deliver the goods... and they did. Within 27 days of order EECo delivered three distribution amplifiers and thirty neon driver amplifiers to Vandenberg Air Force Base.

EECo was able to meet this crash schedule because of the know-how gained in over nine years of supplying timing instrumentation equipment used on most major missile test ranges in the United States. This experience enables EECo design and production engineers to employ R & D production techniques with **maximum effectiveness.**

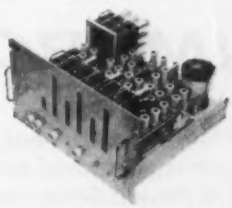
Typical of the instrumentation timing signal hardware sold by EECo are the airborne time code generators, distribution amplifiers and time code generators described below. For full data on these units, request Data File 101.

AIRBORNE TIME CODE GENERATOR provides a 10-digit time code recycling every 900 seconds. Output is pulse-width modulated for direct recording on oscillographs or as an AM carrier signal for recording on magnetic tape; also produces signals for timing lamps in cameras. Accuracy is one part in 10^3 with a stability of one part in 10^4 per day. Active elements are semi-conductors or magnetic cores.



DISTRIBUTION AMPLIFIER (with neon driver in photo). Transistorized time code amplifier for handling up to 12 driver amplifiers for energizing neon timing lamps in instrumentation cameras. Accepts two timing signal inputs either of which can be supplied to any of 12 output circuits each capable of producing input for driver. Driver connects directly into timing signal cable near camera.

TIME CODE GENERATOR. Stable, crystal controlled unit generates 24-hour time-of-day code in modified binary-coded-decimal form. Each second is identified with 20-bit code. Code continuously displayed on hours, minutes, seconds and may be pre-set to clock time. Code automatically recycles at end of 24-hour interval. Drift is less than one second per week.



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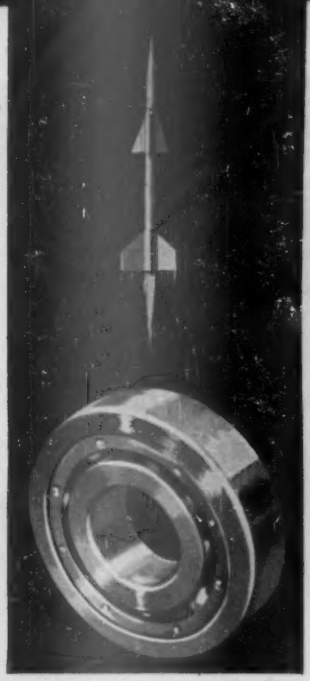
Several new titanium alloys may prove to be the answer to designers' needs for improved tensile and fatigue strength, ductility and corrosion resistance in aircraft and spacecraft materials.

One of the alloys is Crucible B-120VCA. This new, weldable alloy has the highest strength/weight values of any structural material available. At 220,000 psi, its strength/weight ratio is equivalent to that of steel at 360,000 psi. And it maintains its strength/weight advantage for short times at temperatures up to 1400° F. Furthermore, B-120VCA is "Formageable"® (readily formed in the "soft" solution annealed condition and then strengthened by age-hardening).

As this is written, about 50 aircraft and missile manufacturers are testing Crucible B-120VCA samples. They're reporting: (1) it's easier to fabricate than any other titanium alloy; (2) it seems ideal for rocket motor cases, structural members, rivets and other components.

Several other critical design problems are being solved by Crucible vacuum-melted steels and superalloys. Some Crucible alloy and tool steels, for example, possess tensile strengths in the 280,000/300,000 psi range and even higher. Up to now, getting uniform transverse ductility at this strength level has been a problem. Crucible solved it through vacuum melting.

These developments are typical of Crucible advances in specialty steelmak-



a. *Lowering a consumable electrode into a vacuum arc furnace. Metals produced by vacuum melting are "cleaner" and therefore offer improved strength, ductility and longer fatigue life.*

b. Titanium, *more than 1000 lbs. of it, saves 800 lbs. in Convair 880 because of metal's high strength/weight ratio. Principal use is in jet engine pods, aileron, stabilizer, and tail assembly.*

c. Crucible Vacuum-Melted Bearing Steel *makes stronger, longer-lasting bearings. Rejects during manufacture and early failures are virtually eliminated.*

d. Vacuum-Melted 4340 *was specified for hook pivot pin of bomb rack and rocket launcher when air melted steels failed to withstand 4½ hour destructive vibration tests.*

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ing. They're possible because Crucible is completely integrated—and because Crucible pioneered in the development of titanium, the high temperature alloys, and in vacuum induction melting and vacuum arc remelting techniques.

Today, Crucible's experience—and newly-increased capacity for vacuum arc remelting of its own special air melted and vacuum induction melted electrodes—provides industry with a complete range of High Purity Metals at lowest cost.

If you'd like to know more about this work, read: "Titanium for Aircraft and Spacecraft" and "Quality Aspects and Engineering Properties of Vacuum Melted Super Alloys and Steels". Write: *Crucible Steel Company of America, Dept. AG-17, The Oliver Bldg., Mellon Square, Pittsburgh 22, Pa.*

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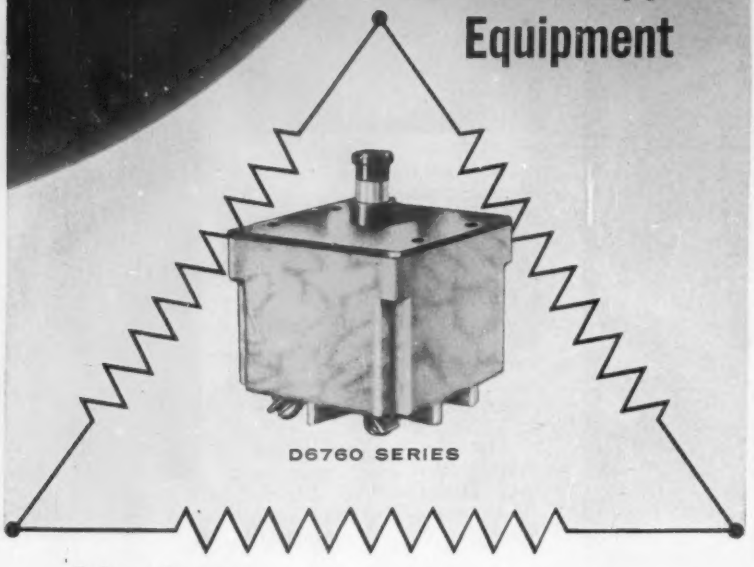

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- Single button opens or recloses all three phases.
- Quick trip . . . 2 to 6 milliseconds on short circuit interruption.
- Shock resistance 25G's.
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The KLIXON D6760 series three-phase circuit breakers are especially designed to handle extremely high AC short circuits. Variations of the D6760 are available providing—larger reset button to facilitate manual operation (-1 model) . . . greater electrical clearances between phases for short circuit interruption of 800 to 1000 amperes at 440 volts (-5 model) . . . with a two-pole construction for aircraft AC electrical systems (-6 model) . . . different ampere ratings in each phase to break three loads of different current values simultaneously (-7 model). They are available in ratings from 5 to 60 amperes. Minimum AC rupture capacity 2500 amps, 1 ϕ, 120 VAC, 400 cps.

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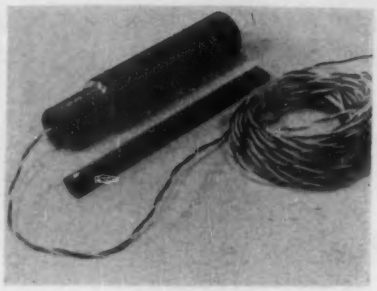

CAGE for measuring surface temperature of an ablating heat shield is made in the form of a plug for easy installation in flight test vehicles.

gaseous state without actually liquifying.

• **Materials which sublime** but do not change their chemical composition and react with the constituents of the dissociated air surrounding the nose cone during re-entry.

• **Materials which first** melt and then vaporize.

• **Composite materials such** as reinforced plastics that pyrolyze or burn and char.

Dr. Leo Steg of GE's Missile and Space Vehicle Department, who played a prominent role in the company's development of a comprehensive theory describing ablation, discussed four ablating materials, one in each of the above categories, which are under serious consideration today for various re-entry conditions.

One of the most promising reinforced plastic composite materials is phenolic nylon.

Dr. Steg indicates that quite a large number of different resins or bonding materials and various reinforcing materials are under study. The phenomenon occurring in the materials and the ionized boundary layer air around the vehicle vary widely with the magnitude of the heating and the length of time that it continues. In general, heat shields of these materials pyrolyze into a gas and form a char on the surface. Pyrolysis takes place some finite distance under the char layer at the surface of the virgin material. This releases oxygen which diffuses to the outer surface and reacts there, burning some of the char away. Therefore, the char layer has a finite thickness during the re-entry. Inorganic reinforcing materials tend to delaminate and create a char layer that grows in dimension while organic materials produce a shrinking char layer.

Dr. Steg points out that if nylon is used as the bonding material in a heat shield, it melts and vaporizes and reacts with the boundary layer air without leaving a char residue, while phenolic resin forms a char.

The nylon, however, releases lightweight gases into the boundary layer as

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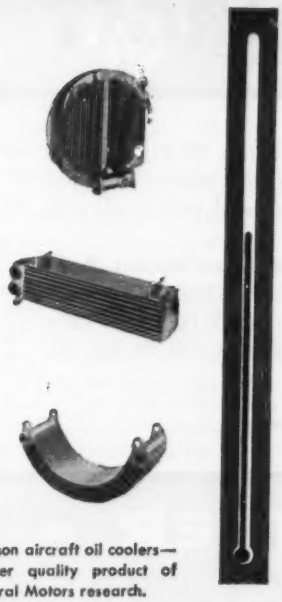

Harrison aircraft oil coolers—another quality product of General Motors research.

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it burns. This is important since the efficiency of any mass transfer cooling system increases as the molecular weight of the cooling gases is reduced. Such gases will absorb more heat and enlarge the boundary layer to a greater extent and, therefore, increase the heat "blocking" to the surface of the vehicle.

Phenolic nylon resin combines the best qualities of nylon, which releases low molecular weight gases upon combustion but does not char, and the phenolic material which does char. The advantage of a resin using the two materials in about equal amounts is that lightweight gases are released into the boundary layer so that heat blocking is large and heat rejection by radiation from the char layer is very high.

Design Problems

Design problems of matching the proper resin and reinforcement to specified re-entry conditions are many. They include the fact that the beneficial effects of radiation from the char layer vary considerably with the temperature of the surface and that dimensional stability of the surface of any composite material depends upon the character of the char layer. Steady state ablation does not appear probable with these composite materials, according to Dr. Steg, and considerable development apparently must be accomplished before a very light, thin and dimensionally stable heat shield can be used with confidence at very high re-entry speeds and large ballistic parameters.

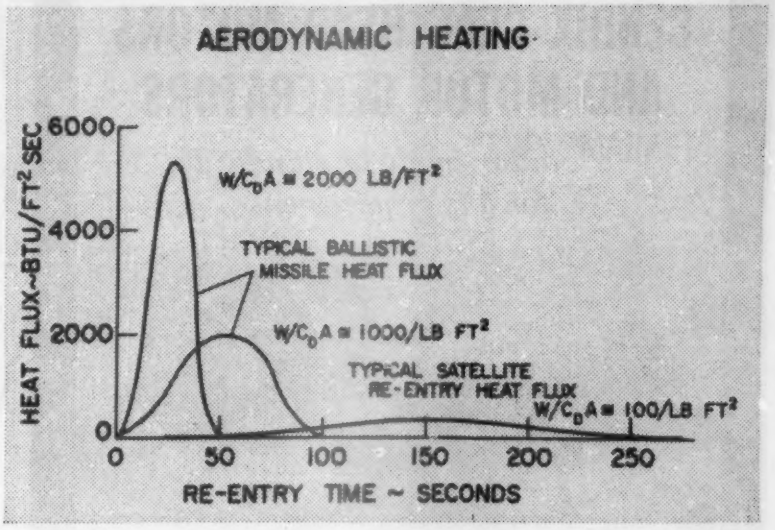
Silicone, melamine and 91LD (a product of Cincinnati Testing Laboratories) resins also have performed well in tests conducted by General Electric, Dr. Steg says.

Glass is typical of the third class of materials for it melts before it vaporizes and releases gas into the boundary layer. Most practical materials do not sublime, and only those with very high viscosity such as glass can be used as ablating materials for high speed flight.

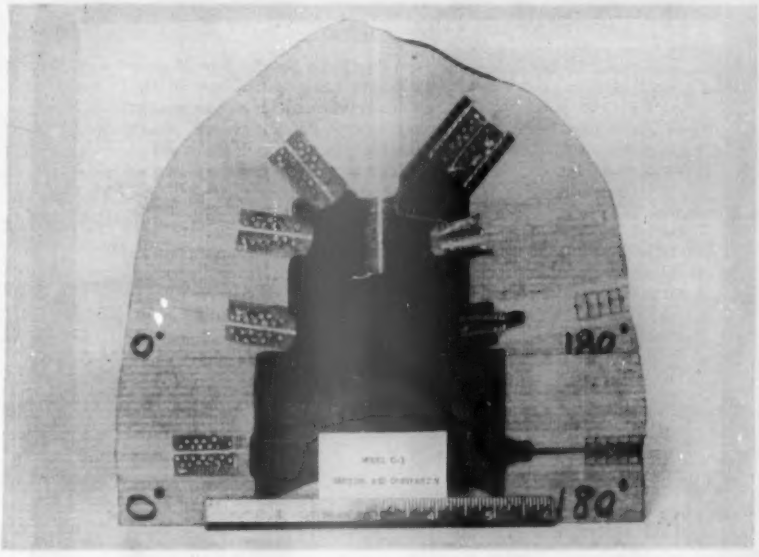
These materials have several ways in which they absorb heat. First, the phase changes from solid to liquid to gas remove heat. The molten glass flows downstream and carries a portion of the heat away from the solid. The gaseous products which are generally composed of dioxide, monoxide and oxygen thickens the boundary layer and lowers the heat flux to the solid body. High surface temperatures also increase the ability of the molten surface to radiate heat away.

In general, however, glasses or substances with high silica content are not good radiation materials, and additives are included to either absorb or scatter both incoming and self-radiation from the heated surface.

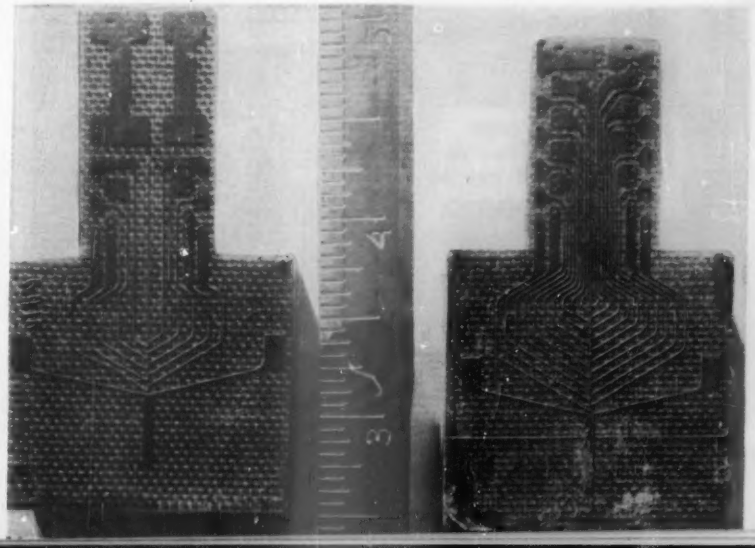
Dr. Steg lists many of the detailed problems which complicate the design



DIFFERENT DESIGN PROBLEMS for warheads and manned satellites are shown here. New ablation type warheads will tend toward short period, very high heat pulses.



DEVELOPMENT of instrumentation for ablation shields is a new art. General Electric temperature, pressure gages which function as shield wears away are shown above, below.



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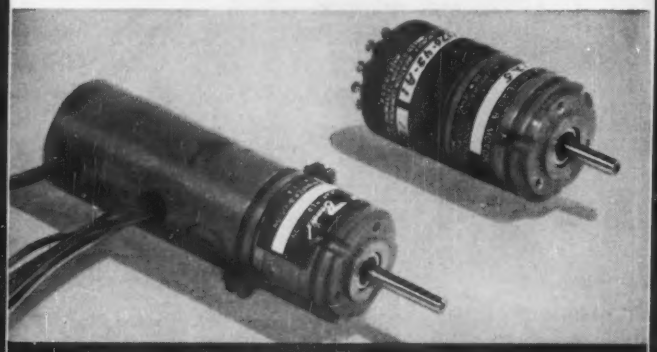

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of heat shields using these materials. One of these is the fact that body and aerodynamic forces may cause the molten material to leave the surface of the vehicle before it is vaporized and, therefore, will not absorb a maximum amount of heat. Under certain conditions of re-entry, a silicon heat shield will act more like a heat sink than an ablation heat shield. When this surface ablation is not taking place, the whole shield will heat up and raise the temperature of the structure underneath.

Graphite is a member of the second class of materials listed above. Combustion takes place on the surface, and the substance does not enter a liquid phase. There is no char layer.

In all types of ablation studies, a detailed examination of a given material requires a number of simplifying assumptions. Flight test and ground experimentation slowly establish the validity or invalidity of these assumptions.

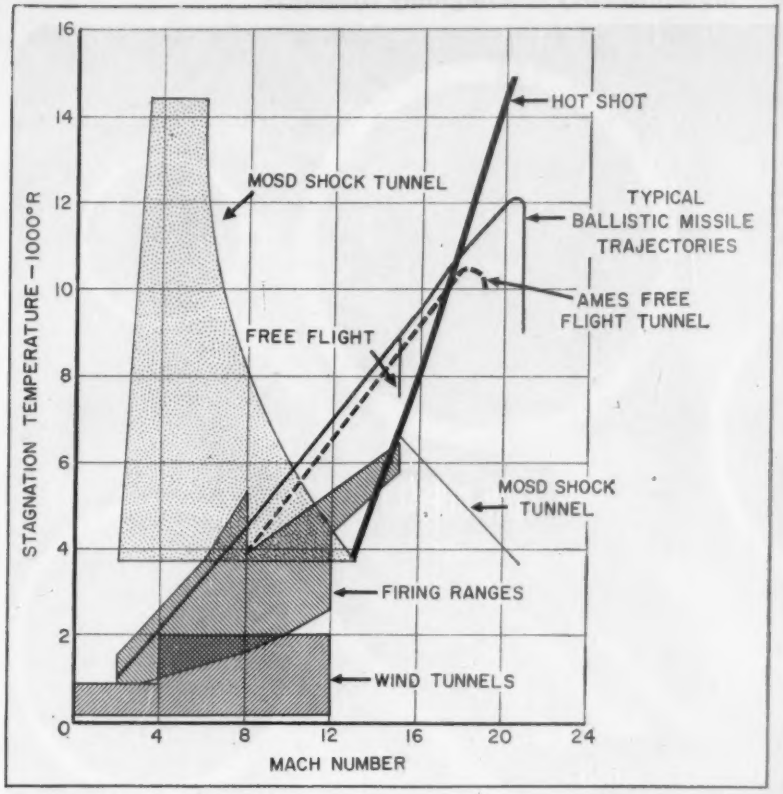
Graphite is no exception, and a very large number of long computer programs and experimentation were necessary before confidence in its use in design work was established.

Dr. Steg reports that, for satellite design problems, a shield using graphite behaves essentially as a heat sink. The ablation rate is exceptionally low, and the design limitations stem from its heat transfer properties and heating of the substructure, thermal shock and methods of attaching the shield to the vehicle.

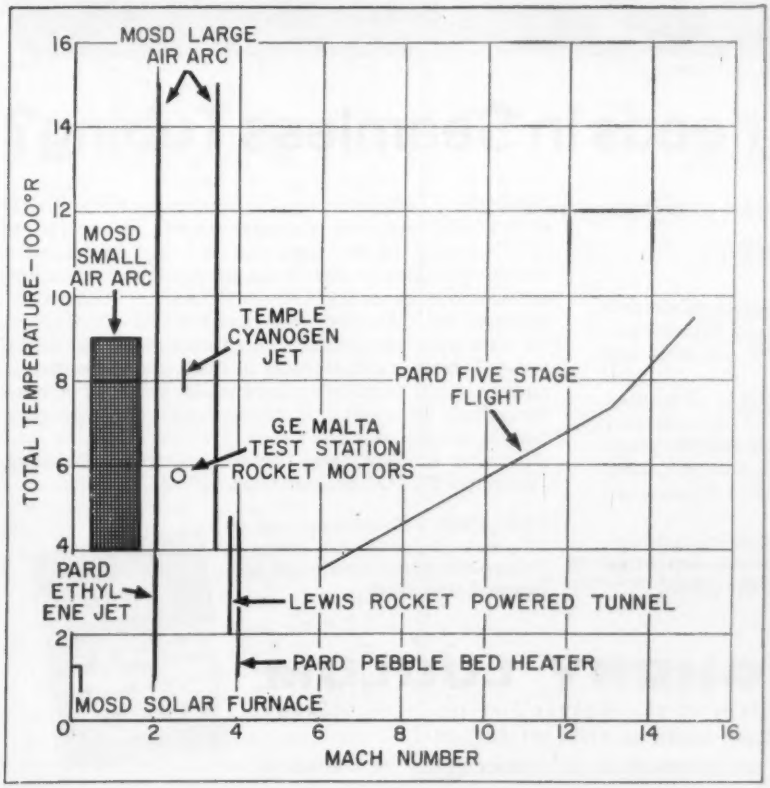
Teflon is a member of the remaining class of ablation materials. Dr. Steg describes its ablation process as consisting first of a chemical change, in which the Teflon depolymerizes into a monomer. This monomer has a very high vapor pressure and flashes directly into a vapor, bypassing the liquid state. About 750 Btu./lb. are absorbed during this process. At higher temperatures, incompletely depolymerized polymers diffuse to the surface, and a number of different chemical reactions can occur that complicate the study of Teflon ablation.

Theoretically, Teflon ablates in a quasi-steady state during most of any re-entry trajectory. The mathematic evaluation of Teflon is simplified because the entire reaction can be considered to take place near the surface.

One of the major considerations concerning the selection of ablation materials for thermal shields is the rate at which they conduct heat. Many of them, including Teflon and phenolic nylon, are good insulators. A light shield of these materials will not allow the substructure of a vehicle to heat significantly during ballistic and satellite re-entries. During the longer heating periods being discussed for hypersonic gliders, the insulation require-



TESTING FACILITIES available for the study of re-entry vehicles and their construction materials are shown above and below in these General Electric curves. MOSD facilities are owned by General Electric. PARD, Ames and Lewis are part of NASA.



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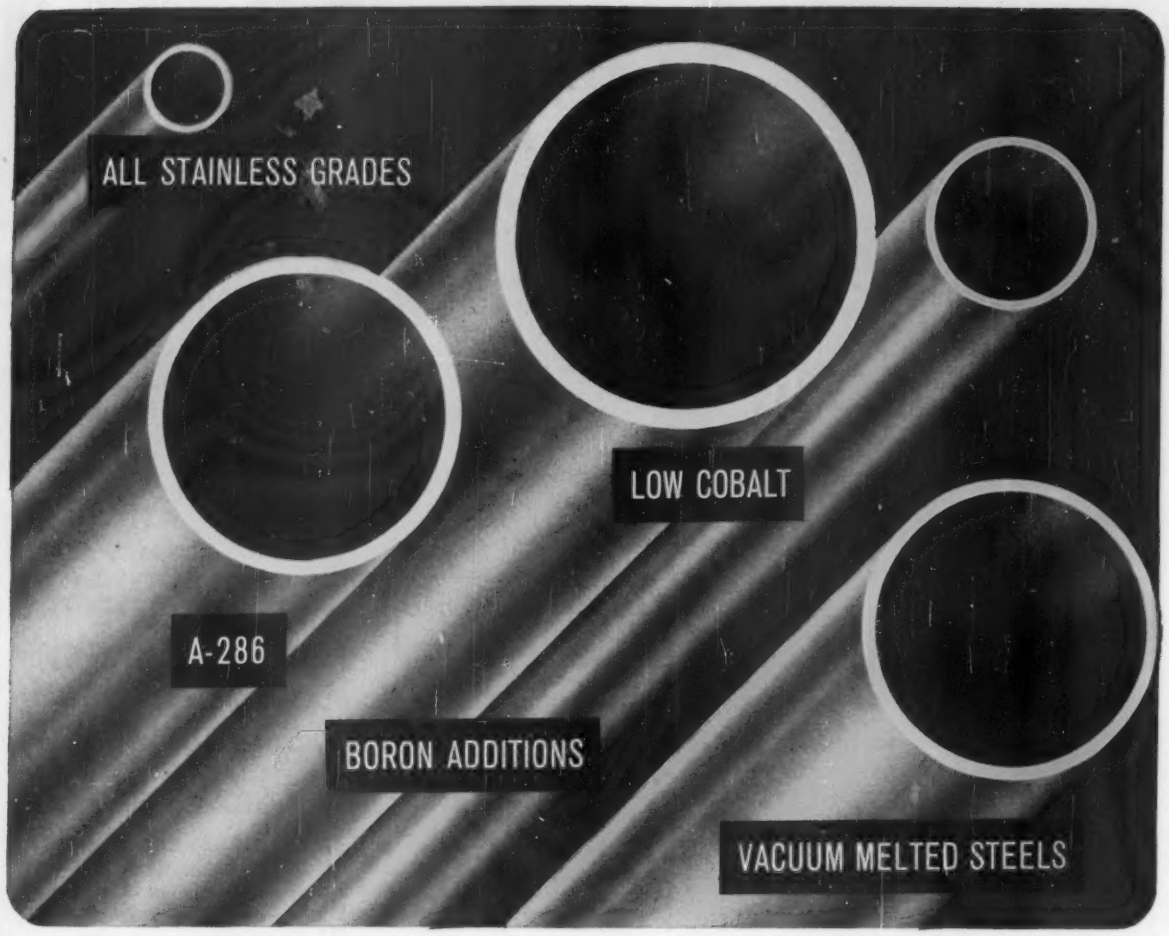

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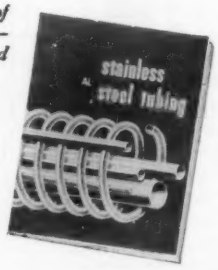

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ments are more severe, and the lightest design may be a combination of an ablation shield backed by a layer of more efficient insulation substance, rather than by using a thicker layer of ablation material.

Ablation design will complicate nose cones for ballistic missiles in one important area, fuzing. Tactical nuclear weapons require elaborate safety mechanisms to prevent premature detonation before firing in order to ensure that they do not fall on friendly areas plus fuzing to provide the most destructive type of explosion on any given target.

Safety arrangements during ground handling and prior to launch would not seem to be affected by the use of an ablation heat shield. The same could be said for the arming device inside the warhead which functions during the flight and decides whether the warhead is going to strike in the general vicinity of the target. This vital unit normally works through the guidance system and provides checks on the trajectory from a number of pressure and inertial units so that it may either program the warhead for self destruction at altitude or arm it for the proper type of fuzing during re-entry.

There are two types of explosions open for use with high velocity ballistic missiles—air burst and the contact burst. The air burst probably also would be backed up by a contact burst.

Fuzing for an air burst at a given altitude can take several forms—radar proximity or radiation fuzing, use of base pressure measurements or static pressure readings from a probe on the front of the nose cone, inertial fuzing which would be based on an estimated trajectory, etc. Each of these methods has its disadvantages and each is best adapted to certain tactical jobs.

Fuzing for a contact burst is usually handled by a spike or area-type of contacting surface. Pressure plates or electrical circuits that are interrupted on contact are usually the main element in the fuze.

There are a number of installation problems connected with placing these various fuzes in ablation nose cones where the outer surfaces are eroded away in contrast to the surface of the heat sink type which holds its shape. Even more difficult than the installation problem is the fact that the second generation ablation cones will travel through the atmosphere more rapidly and strike the ground at a higher velocity than the heat sink models.

Time allowed for fuzing probably will be cut in half. Contact fuzes, for instance, will have to function in an extremely small fraction of a second if they are to detonate the warhead between the time the forward section strikes the ground and the time the entire re-entry vehicle is demolished.

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SHIELDS & COMPANY

August 26, 1959

Coronograph Tested In Strato-Lab Flight

Washington—Airborne instrumentation for study of the sun's corona has been successfully tested by the Office of Naval Research in a manned balloon flight in the Strato-Lab program.

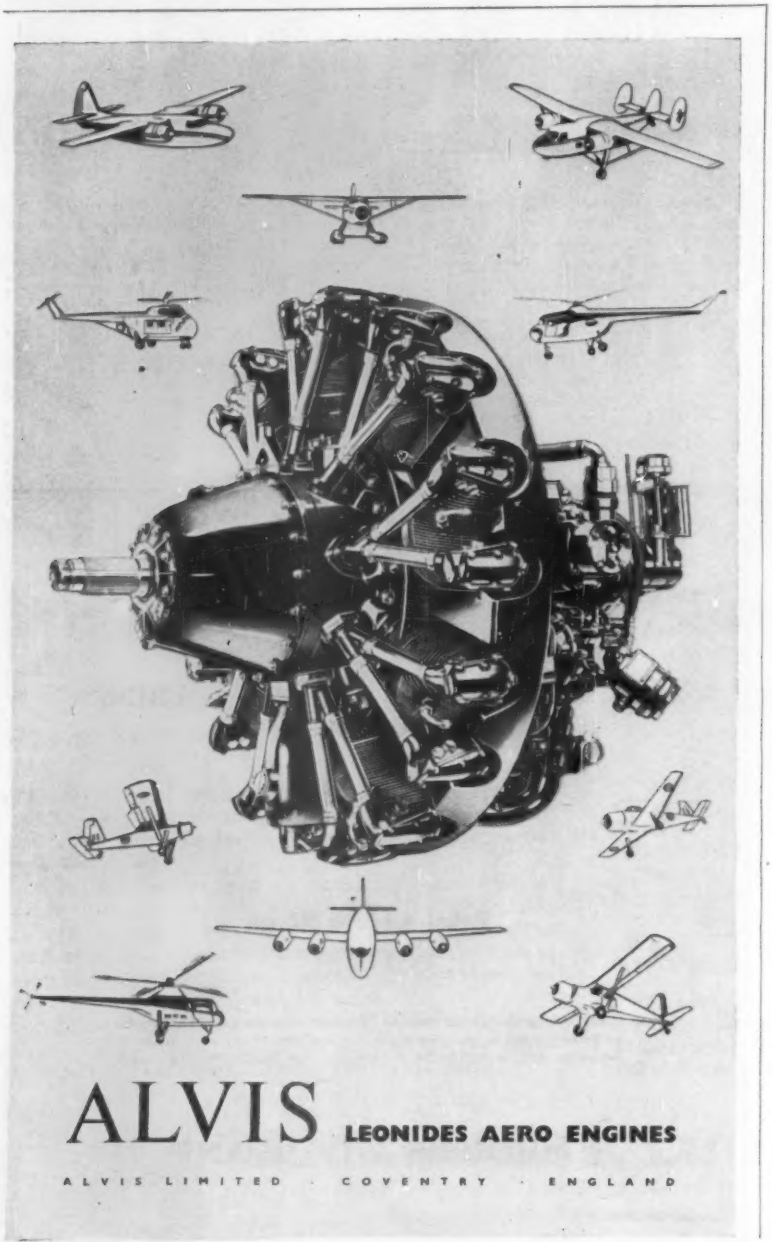
Coronograph was used to photograph the corona of the sun from an open balloon gondola at altitudes up to 38,000 ft. ONR describes the flight as the first in the Strato-Lab series aimed primarily at upper atmosphere research, rather than development of balloon techniques.

Aerial coronograph is a photometer with coronograph-type optics designed to operate in the open at high altitudes and in extreme cold. It was developed for the flight by Dr. Gordon Newkirk, of the University of Colorado High Altitude Observatory. Newkirk is currently analyzing the exposures. Analysis is expected to provide data on particulate matter, such as dust pollen and ice crystals, in the atmosphere at altitudes of up to 38,000 ft. through study of the brightness of the sky in the pictures.

During the flight, the two-man crew could keep the coronograph oriented toward the sun with a motor-driven ring gear mounted between the balloon and the cargo chute which hangs above the gondolo. The crew—Robert Cooper, of the High Altitude Observatory, and Cmdr. Malcolm Ross of ONR—made minute adjustments in the coronograph to complement this rough orientation of the gondola, and they were able to get exposures ranging up to four minutes, accurate within plus or minus four minutes of arc.

Flight was made with a 150,000 cu. ft. balloon made of 2-mil polyethylene carrying a 2,200 lb. payload. After launch near Rapid City, S. D., the flight lasted nine hours, about half of the time at 38,000 ft. Paced by a Douglas R5D, the balloon drifted eastward at 100 kt. at peak altitude. The crew in the open gondola was protected by a new flight suit made of three layers of aluminized neoprene.

Next flight in the Strato-Lab series will be made in October. It will use a 2 million cu. ft. balloon to carry a closed cabin to 80,000 ft. for spectrographic observations of Venus. More flights with the coronograph are planned, but exposures will be made at higher altitudes. Better pictures of the solar corona are also expected from a shift to infrared from the green wavelength used in the first flight.

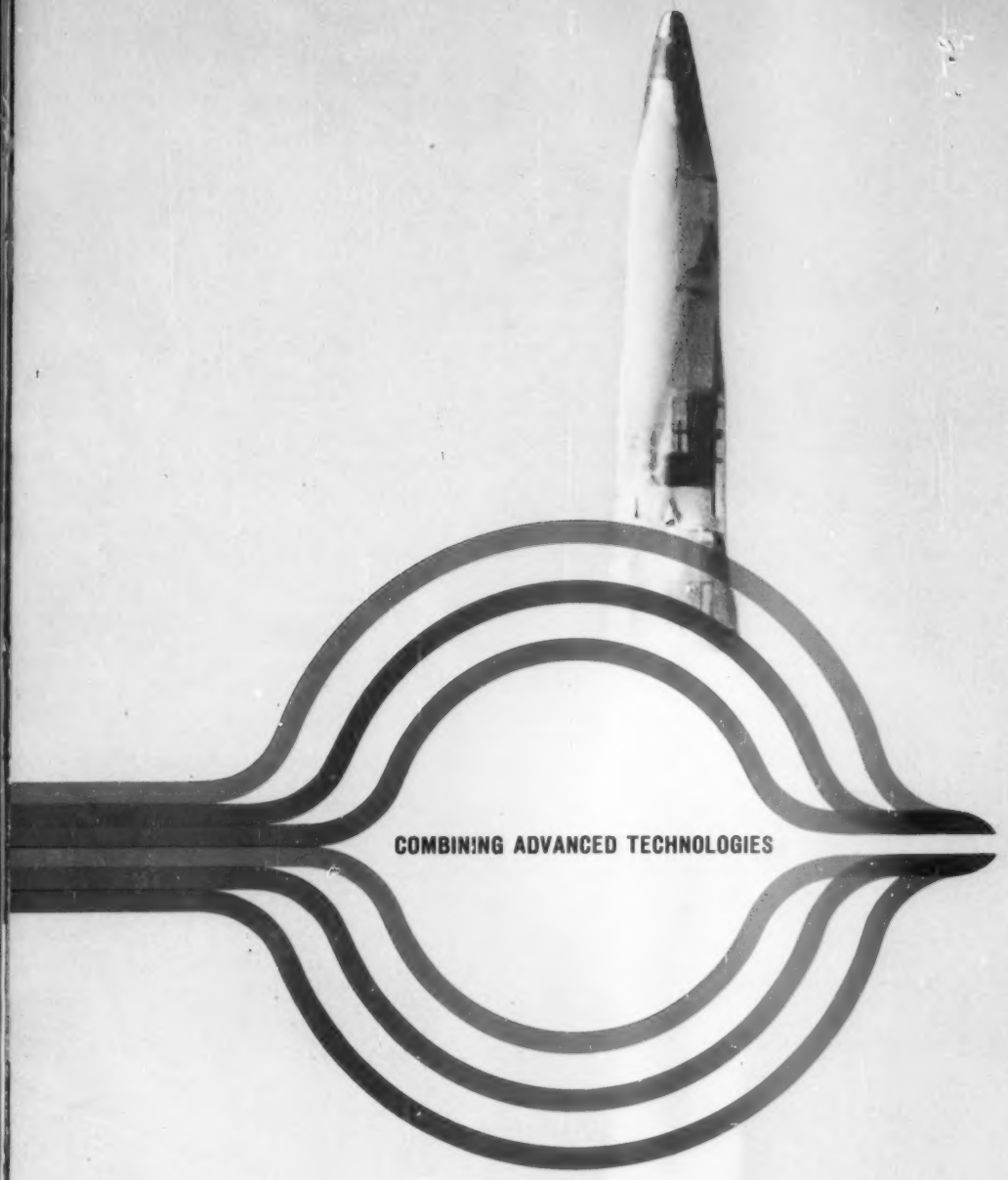


Study Shaped Charge To Separate Capsules

Dallas, Tex.—Refined version of shaped explosive charges, designed to knife through defined areas of aircraft structure, is being studied by Chance Vought Aircraft here as a speedy method of separating crew-carrying cockpit capsules from the remainder of an aircraft or space vehicle.

Prime feature of the shaped charge separation principle, according to company engineers, is that it enables designers to maintain continuity in airframe structures and weight savings compared with other systems that visualize disconnection of a separate, custom-tailored capsule from the vehicle.

Chance Vought's approach is to line the contours of the aircraft behind the fuselage with explosive-carrying three-sided strips of metal, a V-shaped copper strip closing the open side and forming the lined shaped charge. For light surfaces, such as skin, the explosive would be contained inside copper tubing and the shaped charge "V" is impressed along the tubing's length. Tests have shown that on explosion, the jets of metal attain velocities of 30,000 fps. or higher. Chance Vought has tested the system on F8U-1 Crusader fuselage sections and notes that these shaped charge strips and tubes cut through heavy structural members and skin with the cleanness of a knife.



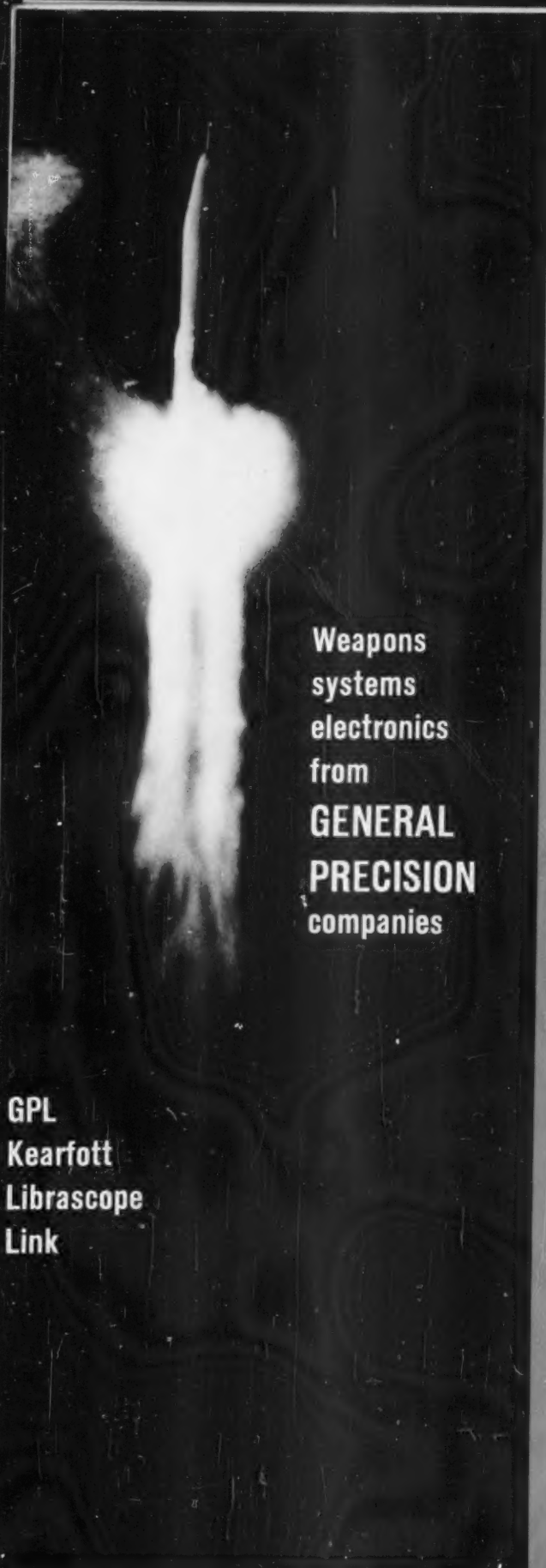
COMBINING ADVANCED TECHNOLOGIES

Modern weapons systems require the interplay of an increasing variety of skills in applied science.

One corporate group with unusually broad electronics-based experience is made up of four General Precision subsidiaries—General Precision Laboratory, Kearfott, Librascope, and Link Aviation.

Working to overall military plans, these companies conceive, engineer and manufacture systems and components embodying the highest state of the art in a wide range of technologies.

General Precision Equipment Corporation



Weapons systems electronics from **GENERAL PRECISION** companies

GPL
Kearfott
Librascope
Link

NAVIGATION, GUIDANCE AND CONTROL

Over 30 operational missiles use extremely accurate and lightweight guidance systems or components produced within the General Precision group.

Inertial, Doppler and astro navigation systems from these companies (including compass systems), and combinations of two or more of these techniques, are in service today, and new systems for interplanetary travel are being planned.

Among many promising research programs underway is development of nuclear gyros —applying the spin of atomic nuclei to inertial navigation.

For seven years General Precision airborne Doppler systems have been freeing military aircraft from ground-based navaids. These equipments have been designed to meet various operational requirements, with accuracies as high as .5% of total distance traveled for the system, .2% of ground speed and .2 degrees of drift angle.

The first man who travels into space in the rocket ship X-15 will use General Precision Doppler in a B-52 launching plane to calibrate and zero in his inertial guidance instruments.

Other equipment from the group in military use today includes analog dead-reckoning computer systems, servomechanism systems and components, hydraulic servo valves, actuators, and depth sensing equipment and joystick controls for submarines.

COMPUTATION AND DATA HANDLING

The diversity of digital computer projects underway in the General Precision companies is unrivaled by any other corporate group.

From these companies have come the most advanced U. S. Navy fire control computer equipment, thousands of production units of special purpose analog and digital computers, and a variety of other computer and data handling equipment.

Among these projects are computer equipments for the Navy's ASROC and SUBROC antisubmarine missiles and the Polaris missile. A versatile digital computer weighing 32 pounds and occupying only one-half cubic foot of space is being produced which solves accurately most navigational problems in aircraft and missiles, accepting inputs from both present and planned navigation sensors.

An airborne bombing-navigation computer developed within the group is being used for the first digital computing-control in production aircraft. Other products include airborne data handling systems, photo-reconnaissance data reduction and control systems, digital servo controls and the desk-sized LGP-30 general purpose digital computer.

In larger equipment, the companies are developing a large scale data processor to serve as the heart of the Federal Aviation Agency's experimental air traffic control system. This integrates one of the first transistorized file-type digital computers with a large capacity drum storage system and input-output buffer system designed to work on line with communications and display systems and printing devices.

A new type of high resolution television equipment from the group is being supplied to the Navy for classified data handling applications.

DETECTION, TRACKING, ACQUISITION AND FIRE CONTROL

The General Precision companies are applying a broad knowledge of radar, including airborne Doppler techniques, to development of new systems for target detection and acquisition, missile velocity measurement and fire control.

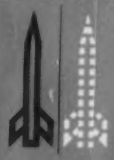
Servo components, microwave components and stable platforms for these systems are designed and manufactured within the group.

This work has led to research in related areas such as high resolution radar and advanced infrared techniques.

An optical tracking device developed and manufactured within the group is being used in a series of space explorations to photograph planets for the first time from outside the earth's atmosphere. This balloon-borne Star Tracker device locks a larger telescope onto its target and enables it to hold the planet's image within one second of arc. A study program on a stellar comparator is also underway.

A large part of the fire control equipment for advanced U.S. Navy surface and subsurface antisubmarine warfare programs is being developed and produced within the group.

SIMULATION, TEST AND GROUND SUPPORT



Training equipment for virtually every type of fighter and bomber in the armed forces is produced in the group.

Progress in human engineering techniques is resulting also in development of simulators designed around sophisticated man-machine concepts—simulators for missile training and for duplication of space flight conditions and submarine operations.

In the field of go-no-go missile test equipment, systems-oriented equipment has been developed which has built-in "reasoning" processes and is capable of reacting to given stimuli.

For example, these systems automatically and continuously test products, systems and components, retaining each test result and rejecting or approving according to pre-programmed standards. Research is being done on "intelligent" machines which one day could devise and build other machines and perform other complex functions, using learning and adaptive processes similar to those of man.

Group technologies have been combined to produce complete ground support checkout equipment including analog, analog-digital hybrid systems, fully digital checkout and programming techniques and automatic electronic components inspection. Another capability is an electronic system called TRACER* for accurate control and unique identification of mobile units and personnel.

General Precision television equipment is in use for remote observation of jet and rocket engines, missile and weapon firings and nuclear reactor operations, for underwater surveillance and visual systems in jet aircraft simulators.

*TRADEMARK

MANUFACTURING SKILLS IN DYNAMICS

Manufacturing military products today depends not only on precision mechanics but also upon scientific application of skills in dynamics—the use of dynamic forces to measure the extreme tolerances required for component and system work.

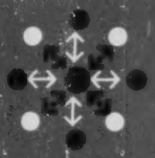
Specially designed equipment is used for this purpose in the General Precision companies. One example, a FRINGE-COUNT* Micrometer, which provides measurements to a millionth of an inch using the wavelength of light as its standard.

Manufacturing with electrons and protons as basic cutting tools, or in controlled quantities as building blocks, is already well advanced in the group. Thin film technology—the deposition of thin films of various materials measured in angstroms—is being developed for unique new components.

Modern facilities for manufacturing and testing within the group include complete environmental laboratories for simulation of all conditions a system or component is likely to encounter, ultra-clean assembly facilities for guidance components, and an unsurpassed temperature-controlled metrology laboratory.

*TRADEMARK

MANAGEMENT AND CORPORATE STRENGTH



The ability of the General Precision group to manage programs on the technical, production and financial levels is demonstrated by a number of important assignments.

One is the prime contract for the key portion of the FAA airways modernization program—the Data Processing Central. This is the most comprehensive systems engineering job ever undertaken for air traffic control, and involves several associate contractor companies outside the group.

Considerable experience has been acquired also through the systems management of a number of ASW warfare and other military programs.

The managements of the four companies and of General Precision determine which company or team is best qualified to carry out specific programs. Financing for all programs also is provided through the parent corporation.

In addition, the group can call on the resources of other General Precision companies—including capabilities in electrical and electronic, photographic and process control fields.

Although these affiliated companies serve mostly non-military markets, their skills are contributing to the solution of defense problems. Recent examples: development of a heat exchanger for a nuclear aircraft engine, and production of the first U.S. military searchlight incorporating a 2,000 candles/mm² light source.

The General Precision companies operate nationwide facilities occupying over 2,500,000 square feet of floor space and employ over 16,000 people—4,100 of whom are scientists, engineers and technicians.

TECHNOLOGICAL "FIRSTS" from GENERAL PRECISION companies.

GPL

1947 Direct reading ground speed and drift angle sensor
1951 Complete automatic airborne global navigator
1954 Automatic airborne polar-mode computer
1954 Operational Doppler navigation equipment
1957 Doppler-inertial system
1958 Track navigation computer
1959 1,000-line resolution television systems in production

Kearfott

1934 Successful airborne radio direction finder loop
1948 Standard USN BuOrd servomotors sizes 11, 15 and 18 and synchros size 11 with "potted" construction and straight-through bore
1952 Precise airborne latitude-corrected directional gyro compass system
1954 20-pound latitude-corrected directional gyro system
1955 Lightweight Schuler-tuned 3 gyro platform in production
1958 Synchro with maximum error of 20 seconds from electrical zero
1959 Inertial system weighing less than 100 pounds in production

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1942 Automatic (attack director) ASW computer
1954 Digital bombing and navigation computer
1955 Desk-sized general purpose electronic digital computer
1957 ASW rocket-propelled missile system
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LINK

1929 Computer-actuated flight trainer
1942 Celestial navigation trainer
1949 Jet aircraft trainer
1954 Digitally-programmed target generator for realistic simulation of interceptor radar missions
1956 DC analog computation in full-scale flight simulator
1957 Missile simulator
1959 Digital function generator for aircraft and engine simulation

GENERAL PRECISION

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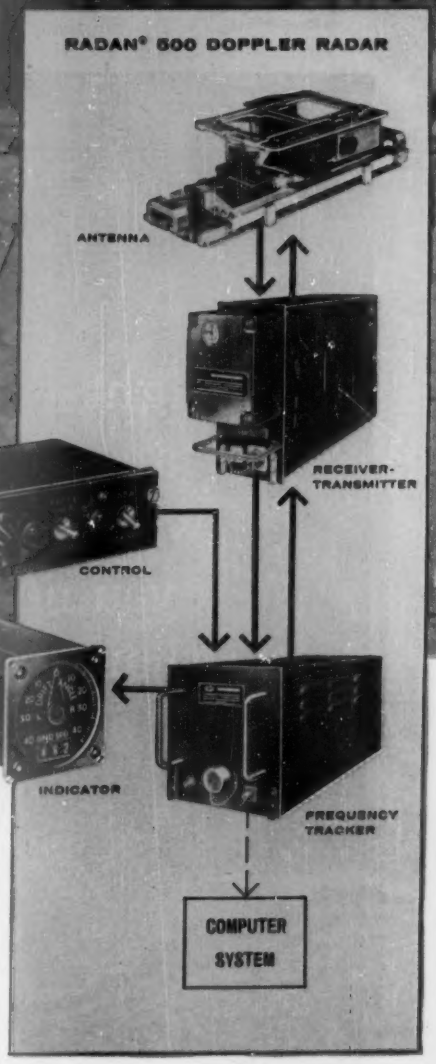
GPL's new commercial Doppler system



RADAN 500 Doppler radar, GPL's all new ARINC system for airlines, offers the reliability and longevity of service that only 13 years of direct Doppler experience can insure...reliability resulting from **flight-proven** designs based on 10 years of product improvement programs, service feedback on more than 1,500 operational GPL Doppler systems, and special attention to the design and maintenance philosophies of commercial airlines.

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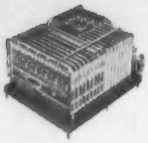

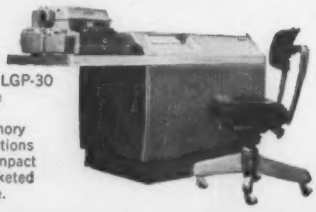

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Inflatable Structures May Have Space Use

By Richard Sweeney

Palo Alto—Possibility that blimp-like inflatable structures may prove the most efficient for space vehicles was advanced at the Durand-Centennial on Aeronautics and Astronautics Conference at Stanford University here by Richard R. Heldenfels, chief of the Structures Research Division at Langley Research Center, National Aeronautics and Space Administration.

In his discussion on the "Frontiers of Flight Structures Design," Heldenfels pointed out that the weightlessness of space flight makes feasible structures designed for low loading intensity, since there are no significant static loads but a whole host of transient and dynamic loads of undefined character of unknown but probably low intensity. In fact, according to Heldenfels, an efficient space structure may not be able to support its own weight if assembled on the ground.

Heldenfels pointed out that problems include basic considerations such as whether or not the vehicle is to remain in space and fly there, or whether it would be used to re-enter the atmosphere and carry its payload to earth. Another aspect he cited is the analysis of and protection against such known hazards as radiation, and impact with meteorites, micrometeorites, and erosion from space dust.

Heat Problem

In addition, the author discussed various means of dealing with the heat problem for vehicles at the re-entry phase of flight, that is, heat sink and the condition where the structure is able to withstand the heat fluxes and inputs while retaining its load carrying abilities, up to its equilibrium temperature, after which additional heat is discharged back into the atmosphere.

The heat sink, he said, is extremely limited by the fact that it must carry such a high weight of material to absorb the heat fluxes and total heats imposed during the long periods of aerodynamic heating encountered during a re-entry phase of flight.

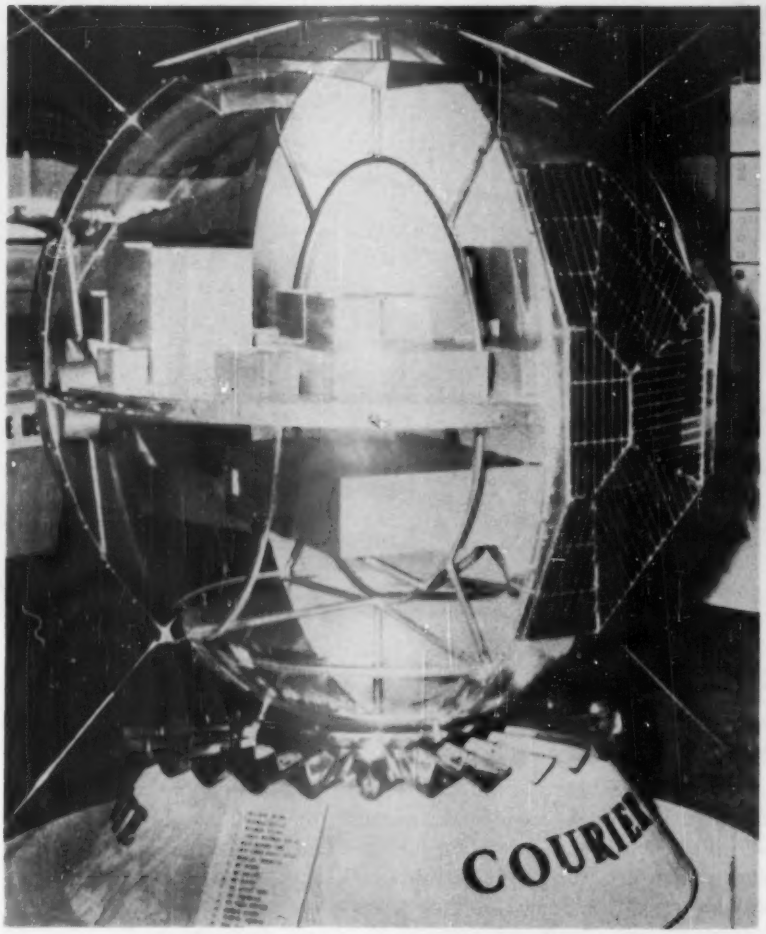
In outlining the drawbacks to design of a hot structure, he mentioned thermal stress across surfaces with different temperature gradients. This could be accomplished, he pointed out, in several ways—either by using materials with similar thermal coefficients of expansion, or by imposing a section between the high heat area and the lower heat, load carrying structure, the section to retain the stiffness required to transmit the loads yet have sufficient flexibility to relieve the unwanted stresses.

The combination of radiation heat shield and insulation is a promising scheme for protecting many types of primary structure, according to Heldenfels. He said that the small amount of heat that penetrates the insulation must be absorbed by the structure as a heat sink or by coolants circulating through the structure. This use of a "low-level" coolant system appears to be the most likely application of a convective cooling system to a flight structure, Heldenfels said.

Heldenfels said that, in general, insulated structures (heat sink) are the lightest when the design conditions are short heating times and high loading, while uninsulated hot structures, i.e., radiative, are best when opposite design conditions of long heating times and low loading apply.

Heldenfels indicated that development of insulated structures is dependent upon perfection of very efficient insulation—packages that can withstand exposure to a high speed air stream and operate with high surface equilibrium temperatures. Success in this area, he says, may well result in the universal application of protected structure in supersonic and hypersonic airplanes and many kinds of re-entry vehicles.

In dealing with the structures which may be expected in space vehicles, Heldenfels pointed out the problems include the mounting of structures atop a rocket nose and boosting them



Army Unveils Courier Communication Satellite

Project Courier delayed relay satellite (AW April 27, p. 28) was unveiled by Army Signal Corps, Ft. Monmouth, N. J. Army plans to orbit the 500-lb. communication satellite in February. Army Signals Corps is also developing ground stations and associated tracking antennas; USAF's Ballistic Missile Division is developing guidance, booster and upper stages. Army Signal Corps is monitoring development of the project for Advanced Research Projects Agency (AW July 27, p. 33).

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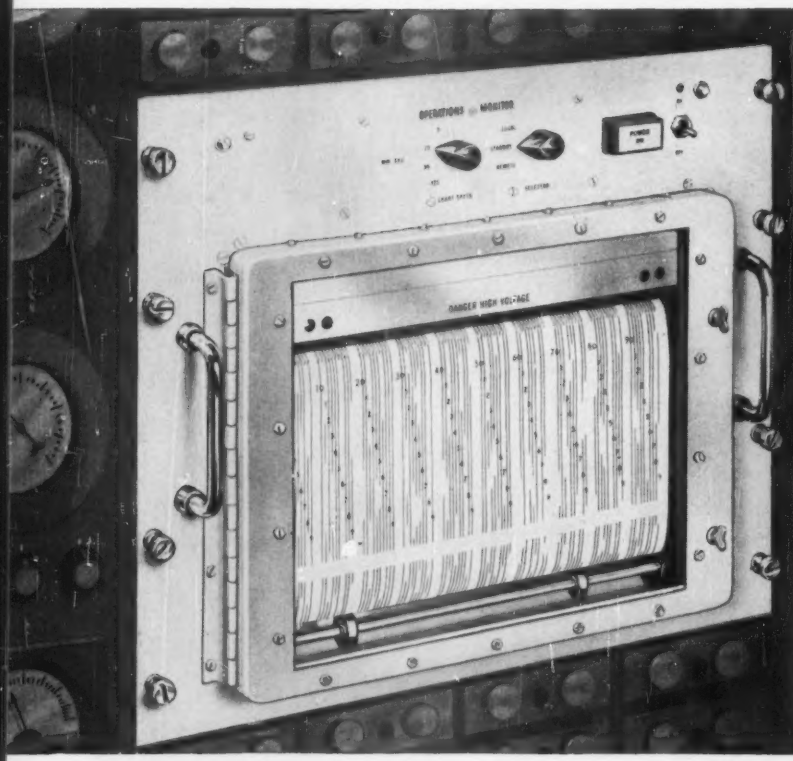

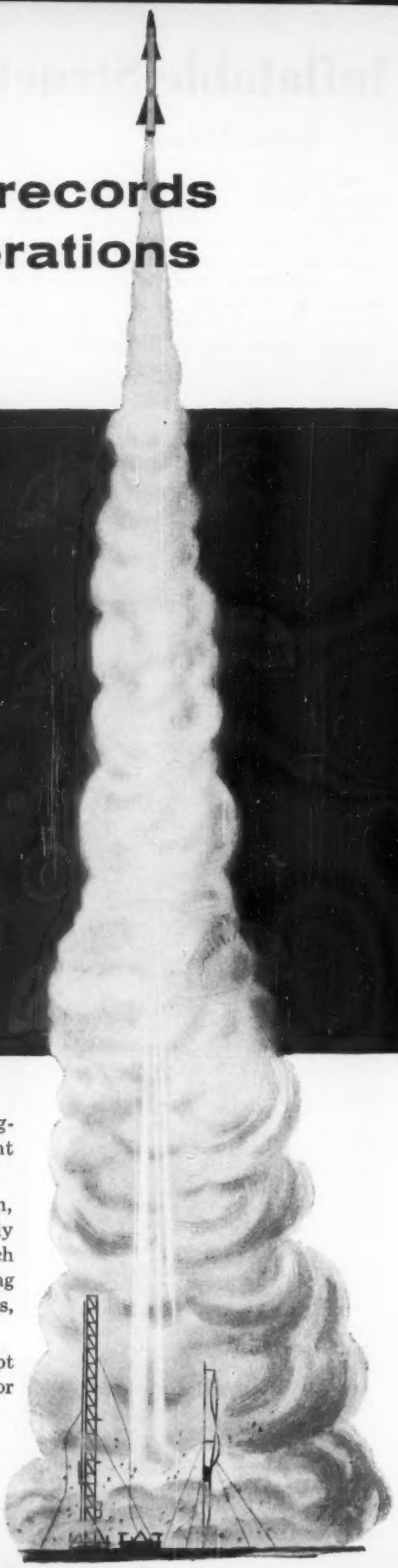

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through the atmosphere. Space vehicles usually are of a design which would prove cumbersome and destabilizing to a rocket boosting them through the atmosphere in the exposed condition. This indicates that such techniques as prepackaging the vehicles and assembling them in space should be a good solution to the problem. Another big problem, Heldenfels pointed out in design of space structures, is adequate testing on the ground, where weightlessness cannot be simulated at present.

As basic structures, Heldenfels indicated three possible types would be monocoque cylinders, which buckle at yield stress; inflated membranes, which carry load by internal pressurization alone, work at the yield stress and become more efficient the larger they get; and a transition bridging between the membranes and pure monocoque wherein a pressurized monocoque is a good solution. A sandwich cylinder is more efficient in this latter range of loading intensity, he indicated, but it is more complex and expensive.

In space applications, weight of the pressurizing gas probably would be considered part of the structure. Using air as the pressurizing agent, weights are altered, but the membrane remains superior at low loading intensities. Use of other gases, such as helium, should reduce the weight for pressurization.

Another approach is the problem which Heldenfels outlined was the use of foamed-in-place chemicals to erect space vehicles after they have reached the space environment. Here, he indicated, combinations of techniques are possible, such as using a pressurizing gas to inflate the structure, then rigidizing the components with the foamed-in-place chemicals. In addition, there are other physical phenomena, he said, which may be developed and utilized for erecting and maintaining space structures.

Personnel Protection

One of the biggest hazards yet to be faced in design of space vehicle structures, according to Heldenfels, is protecting the personnel and their equipment against the effects of space environment. Effects of high vacuum, meteoroids, micrometeorites, and radiation on materials and structures must be determined and suitable provisions for alleviating detrimental effects incorporated in structural design. These problems will remain a frontier until the space environment is more precisely defined in engineering terms and these environmental effects thoroughly documented through ground research and flight testing with satellites, space probes and manned space laboratories.

The Van Allen radiation belts and other radiation in space yet to be discovered may constitute a major deterrent to man's space flight unless lightweight radiation shields can be efficiently incorporated into space cabin structures. Meteroroid damage may also lead to a major weight penalty in many space structures that must survive for long, times of flight. Ingenious schemes have been proposed to incorporate meteoroid shields in these structures but such schemes are yet to be evaluated in service. Much environmental research is needed to yield engineering design data on size, frequency, distribution and velocity of meteoroids so that erosion and penetration problems can be carefully evaluated.

A report dealing with advanced structural philosophies for hypersonic space age vehicles, by W. H. Dukes of Bell Aircraft Corp., dealt with the leading edge of a wing for hypersonic lifting vehicles, in which velocities would exceed at least 12,000 fps. and the requirement for radiative cooling would indicate structural material capable of withstanding 3,000F in steady state conditions.

Material discussed by Dukes was graphite, using a carbide type coating to prevent oxidation at elevated temperatures, one of graphite's biggest problems.

Dukes indicated Bell's work has been

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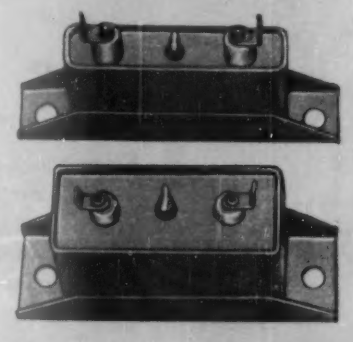

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going on for a year under contract, as part of a study being conducted for Wright Air Development Center, and the objective is the design, fabrication and thermal testing of two leading edges, one in a refractory metal, one in a non-metal, both with 3,000F capability and fabricated from available materials.

Flight times under consideration within the atmosphere were up to two hours, and a desirable additional characteristic was that the unit be reuseable several times, without having to be replaced after making a flight.

Dukes outlined the problems involved in using an absorptive system, including both a protected structure and a cooled structure. Rather than use an absorptive system, his goal was toward use of a radiative system which the graphite would be.

The vehicle was considered as having a 10,000 lb. weight, wing loading of 25 lb. per sq. ft., wing area of 400 sq. ft., with a delta configuration of 60 deg. sweepback, giving a total leading edge length of 61 ft. Assuming a one-half inch diameter leading edge and integrating heat input to only this half-inch diameter hemicylinder for a typical two hour flight, starting at orbital velocity gives a total heat to be absorbed of 3,250,000 Btu., Dukes said.

Hydrogen Cooling

Use of absorbing media to assimilate this heat and dispose of it were prohibitive for a 10,000 lb. vehicle, according to Dukes. He indicated that hydrogen cooling systems are becoming reasonable, but encounter a serious volume problem. In addition, lithium coolant systems are becoming acceptable but system weight would be large and development problems are serious.

In radiative systems there are two ways to reduce leading edge temperatures—increasing leading edge diameter, and provision of good heat conduction paths within the leading edge wall to extract heat from the stagnation point region and radiate this heat back away in the areas immediately behind the leading edge. However, he points out that going along either of these methods, with reasonable values of L/D, wing loading, and maneuvering capability of 2g, the airplane configuration most likely would be seriously compromised in order to keep the temperatures within 2,000 to 2,500F regions. Dukes indicated the following conclusions:

- **Absorptive systems are heavy,** with the possible exception of lithium, but this requires tremendous development.
- **Radiative systems are possible,** if sheet metal molybdenum fabrication is developed, with compromise in vehicle configuration to minimize leading edge temperatures. Such a step may be an interim arrangement suitable for the

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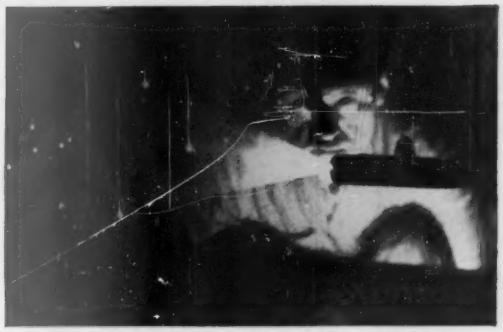

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• **Leading edge** that will not severely compromise the vehicle must have a capability of at least 3,000F and requires either sheet tungsten or use of non-metallic refractory materials.

In selecting materials for the leading edge, three design considerations were used by Dukes. These were oxidation resistance in a moving airstream, strength to resist aerodynamic forces, and the ability to properly deal with the thermal stresses which can arise either due to transient flight condition or to the very large variation in heating rate within immediate vicinity of the leading edge.

In selecting a material with respect to thermal stresses, not only is the strength to resist thermal stresses important but also the physical properties which determine their magnitude. A small value of the product of coefficient of expansion and elastic modulus leads to low thermal stresses.

Graphite, according to Dukes, has these virtues.

Although graphite does not meet all conditions specified as desirable by design requirements, it does have high conductivity, low modulus of elasticity and coefficient of expansion. Also, it has low strength and poor oxidation resistance. However, much has been done with protective coatings for graphite, according to Dukes.

One problem in the design study, Dukes indicated, was lack of data on various materials being considered, thus a two phase material test program was initiated. First phase was a screening to provide data for material selection and the second phase was to provide detailed mechanical and physical property data for the selected material.

Materials Tests

Various methods of testing were used to determine the properties of the materials being considered, both the strengths, temperature resistance and other parameters. Considering the coating available for use with graphite, Dukes said it is reported to have self-healing properties, and, despite graphite's low strength, it has promise of considerable strength improvement in the pyrolytic forms now being studied.

Cost was a deciding factor between the use of a dense silicon carbide leading edge and graphite Type 1. Graphite was easy to machine before coating while silicon carbide was entirely diamond-ground, producing a large cost difference.

Development of a philosophy for brittle material design was based on recognition of the absence of yielding, with the consequence that failure will occur when the stress at some point, however localized, reaches the limit of material capability, Dukes said. This produces a number of problems not usually present in metallic designs.

This necessitated, according to Dukes, knowing completely the reactions of leading edge attach points; for instance, any loads induced by relative deformations of the wing and leading edge which may be due to applied loads or thermal expansions, loads induced during assembly or by misalignment of attach points. The solution adopted was to attach the leading edge element in a completely and absolutely non-redundant manner.

Tolerance Problems

A second problem was due to tolerances and fits—in metallic construction, mating faces can be brought to proper relationship by local yielding which is not permissable in a brittle material and may induce large stresses. In addition, tolerances must be considered not only on principle dimensions but on angles, parallel faces, hole diameters, etc. In the case of coated graphite, tolerances also arise due to variations in coating buildup and cannot be reduced except by diamond grinding of the coating.

To resolve the problem, all mating surfaces between metal and graphite must be self aligning in direction and adjustable in position. With a brittle material stress concentrations which arise at section changes and at externally applied loads introduce effects which may be significant as primary stresses. In fact, with a brittle material the distinction has little significance since both are equally important in producing material failure.

Standard engineering theory must therefore be supplanted by a theory of elasticity to predict the localized effects. Also, normal procedures used to select section proportions are modified to include stress concentration effects.

Another problem concerns thermal expansions between graphite and attaching metal parts, and the problem is due to the fact that the metals used expand four to five times as fast as graphite. At 800F, therefore, the relative growth is about 10 mils per inch, which will destroy all fits.

Solution to this depends on the fact that for uniform temperatures a part retains its geometric proportions during expansions, and angles are unchanged. If the projections for all mating surfaces between graphite metal parts are made to intersect in a common point, there will be no relative change of fit due to expansion differences.

Final problem was flaws in the material, a special form of stress concentration in that the size, shape and position cannot be defined except on a statistical basis, and the problem was treated on a statistical basis as an effect on the allowable stress, which is chosen to ensure prescribed probability of failure. The next point dealt with by Dukes was the method of attaching the comparatively short sections of leading edge to the metal wing structure. A type of leading edge attachment was proposed, based on the principle of elimination of redundancy. Each of three attach points used is capable of taking loads in only one plane. This is ensured by attaching each point to a simple truss hinged at the main structure. Two of the trusses are in the vertical plane to take vertical, fore and aft loads and rolling and yawing moments, while the third truss is horizontal to take side loads. Pitching moment couple loads are divided statically between all three trusses. Complete freedom of rotation is provided by a spherical bearing at each attach point. A conventional metal skin structure is used between the graphite and front beam of the wing.

Approximately 10 design concepts were studied for the attach points. Many individual designs were examined under each concept. These ranged from forms of standard lug in which attempts were made to minimize stress concentrations, to clamps, shrink and expansion fits, threaded holes in the graphite, brazing to the graphite and major modifications of a dovetail joint, successfully developed by NASA a few years ago for ceramic turbine blades.

First type of attachment was termed standard lug, typical of metal construction in the external shape. Most of the problems were concerned with obtaining a good fit between metal and graphite parts and accommodating thermal expansion. The spherical bearing is carried in a metal housing which is tapered to fit into a tapered hole in the graphite. This is held in place by a washer and nut.

Compromise Required

There was a compromise required, in that the angle of the taper must be the same in the graphite and metal to obtain a good fit, no other dimension is important and other tolerances are accommodated. The graphite washer is used so that the projected plane of the conical hole intersects the plane of the flat metal washer. This ensures that thermal expansion of the metal will cause no change in fit with the graphite. A nut with a spherical seat is used since the axis of the hole may not be truly normal to the face of the graphite. The arrangement requires a cantilever support from the metal fitting, which may be a little heavy but offered no real problems.

In the next plan, the spherical bearing is carried in a cylindrical metal housing which is provided with slots so the supporting structure can be brought in adjacent to the bearing. The housing fits in a V-notch in the graphite and a

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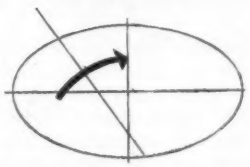

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good fit is achieved without regard for exact diameter of housing or angle of notch or parallelness in the faces. Housing is held in place by two metal straps which wrap around projections on the graphite, and here again dimensional accuracy is unimportant due to flexibility of the straps and screw adjustment at the ends. Thermal expansions of the metal are accommodated with this arrangement since the extension of the strap and increase in diameter of the bearing housing are proportional, contact point moves along the slope of the V-notch and the fit is maintained.

In this design, a compromise was made in favor of tolerance problems by accepting stress concentrations, resulting from the line contact at the bearing housing. This is considered acceptable, since the resulting stresses do not combine directly with the bending stresses in the lug. Refinements are still desired in both designs to eliminate excessive prestressing of the graphite due to the tightening of the nuts.

In sizing these lugs, there are two steps to be taken. First, find the geometric proportions which minimize the stress; second, fix the actual sizes for the given loads.

Critical Points

Using the second attachment scheme as an example of the type of work that was done to determine the best lug proportions, Dukes indicated three points are expected to be critical—contact stresses under the bearing housing, the bending stresses at the base of the notch, and the local stresses adjacent to the tension strap.

Contact stresses are minimized if the half angle of the wedge is 30 deg., according to Dukes. Wall thickness of bearing housing was designed to minimize contact stresses by providing stiffness to spread the load almost uniformly along the graphite.

Computing the tension stresses in the radius of the wedge, Dukes said, they were found to include concentration factor due to the radius, the tapered beam effect, and also the short beam effect which tends to make the top of the beam ineffective. It was found he said, that it was desirable to use a beam depth of about three times the bearing housing radius, since this eliminates tension stresses. This turned out to be impractically large, Dukes pointed out, so that it was possible only to approach this value.

Similar considerations were applied to the local stresses in the graphite due to the strap load.

To select actual lug sizes, allowable stresses for the coated graphite were required and at present, according to Dukes, there are only modulus of rupture data, so that several assumptions were necessary. Test data showed that coated graphite gave lower strength than the uncoated material, indicating that the coating is strain limited. From measured deflection data, strain at the surface at failure was computed for each specimen and this was used with Weibull's Statistical Distribution Function to determine permissible strain for a probability of failure of one in 100. This resulting allowable strain is 0.7 x 10-3 in./in.

A value of 2 million was obtained for the elastic modulous of the graphite from screening tests on bare material, Dukes said, and value of about 4 million was obtained from the coating by using measured deflection data and an assumed coating thickness. The coating is a diffusion type and an effective thickness of .015 in. was chosen from a plot of coating concentration against depth.

Resulting failure stress in the coating is 2,800 psi., and where the coating is not limiting, a stress of 3,750 psi. is permissible in the graphite. Only literature data is available on compression strengths and a value of four times the tensile strength was taken. Shear allowables were obtained assuming the Mohr failure theory.

Experience with hypersonic vehicles shows the most critical load conditions occur during low-speed parts of the flight, according to Dukes. Maximum g is generally achieved at moderate supersonic speed at low altitudes while the vehicle is being boosted. Maneuvers are only those necessary to maintain flight path, consequently only small angles of attack were to be realized. Severe maneuvers involving high-angles of attack are only expected near the end of the flight at low supersonic or subsonic speeds. Three cases were selected for designing a typical leading edge—maximum dynamic pressure, maximum angle of attack at supersonic speed, maximum angle of attack at subsonic speed.

Most critical case turned out to be the high angle of attack, low-speed condition due to the large net lift force, corresponding to an average pressure of 6.8 psi. Assuming a couple arm between the upper and lower attach points of 3 in., this condition gives upper attachment load of 350 lb. and lower attachment load of 545 lb., for a leading edge element 18 in. long.

From these loads and allowable stresses, the two types of lugs were designed in preliminary fashion. Standard lug turns out to be 2.3 in. deep and 1.0 in. thick and the external type lug has a total cross section of 1.6 in. deep and 2.1 in. thick. It turned out, Dukes said, that the latter proportions can be varied in any manner, providing that the product remains constant. The factor which fixes the individual values is the radius of the bearing housing

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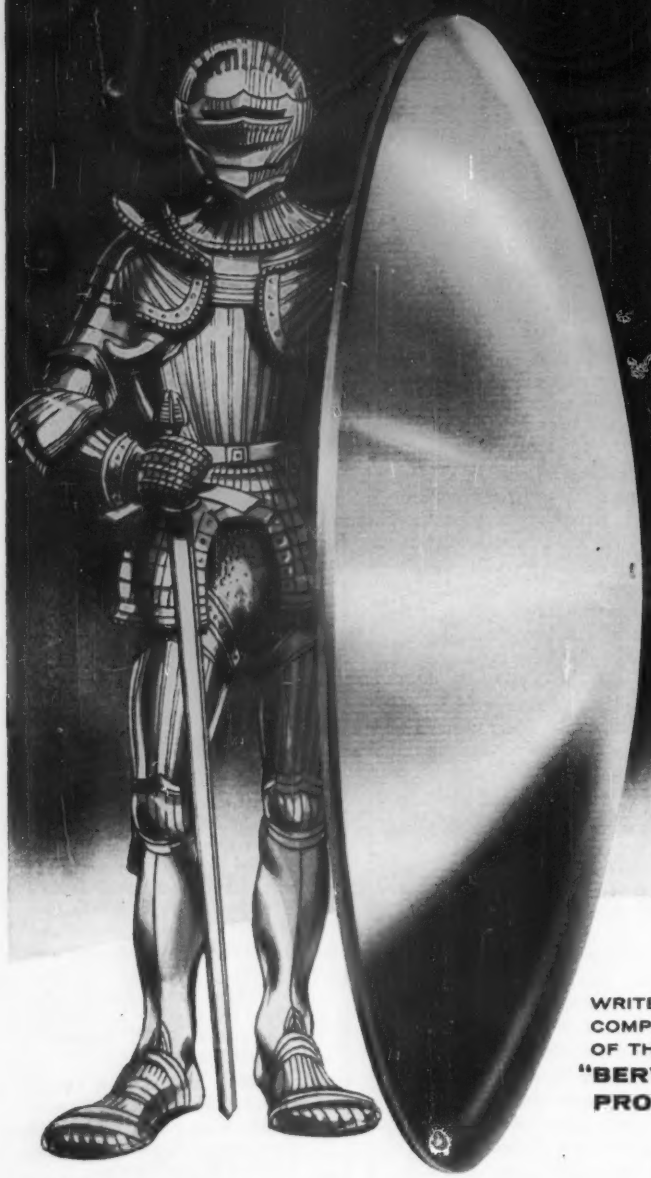

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and for the value chosen, the bearing housing was 1.0 in. in diameter.

A limited test program has been initiated, Dukes said, in an attempt to verify the designs evolved so far, and in this program three specimens have been made of each of the two attachment fittings. To simplify comparisons with theory, the attachments were constructed in uncoated graphite.

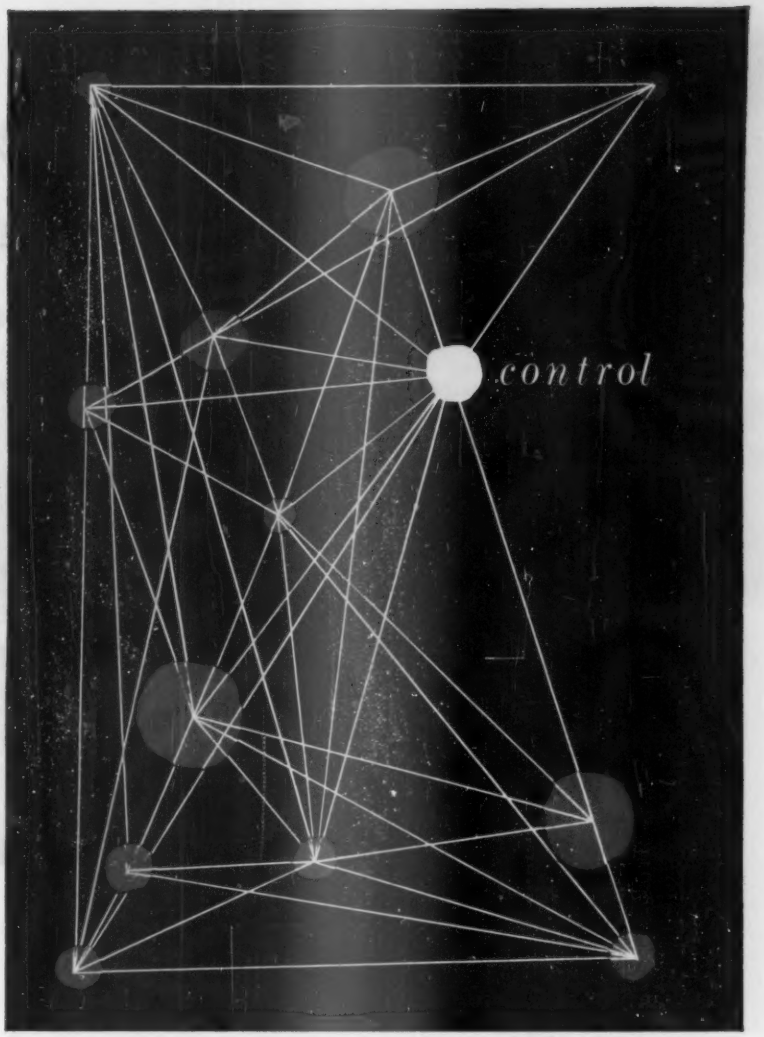
The next step was to select the leading edge shape and size and shell wall thickness. It was obvious from the studies of attachments that these cannot be accommodated within a small diameter leading edge, that at least a 3 in. diameter would be required. Furthermore, a ¼ in. wall thickness is considered minimum practical in graphite. It was decided that a leading edge radius of at least 3 in., assuming a reduction of maximum temperature of 150F due to internal radiation, the maximum temperature would be 3,000F which is within the permissible set on the basis of demonstrated oxidation resistance. Evidently, Dukes said, the size of the graphite leading edge would be dictated by the requirement of space for the attachments.

It was intended to select a chordwise dimension by extending graphite to the point where the temperature reduces to a value acceptable to conventional metals. At an angle of attack, the lower surface temperature reduces very slowly with chordwise distance, and for W/SC_1 value of 100, it was not considered practical to drop temperatures below 2,000F, which requires 5 in. chordwise dimension. At this temperature, the metal performance must be selected for oxidation resistance and a material such as Inconel 702 would be required. Material strength is low at 2,000F, but is sufficient for the loads.

The resulting design for a leading edge element 18 in. long showed a 5 in. chord, a 4 in. nose diameter, and consists of a ⅜ in. thick coated graphite shell with three ¼ in.-thick integral ribs spaced 6 in. apart. The attachments are integral with the ribs. Shell thickness is required to carry pressure load to the rib.

For the present, smallest, lightest, practical, presently feasible 3,000F leading edge, the total weight is about 7.0 lb. per ft. of leading edge length, or about 400 lb. for the 10,000 lb. vehicle discussed.

The next stage of the program now in progress at Bell, according to Dukes, involves more extensive materials testing to obtain comprehensive design data on coated graphite. The program will include tension, compression, modulus of rupture tests, thermal and oxidation tests. Temperature range to be covered extends to 3,000F. Some 690 graphite specimens are involved in this program.



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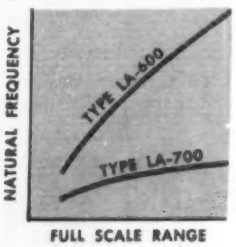
The virtual elimination of friction in both these new Honeywell linear accelerometers is made possible by a unique web spring suspension. This feature combined with an electro-magnetic pick-off permits resolutions of extremely low level inputs.

These two instruments span the entire range of dynamic performance.



The LA-600 with its magnetic damping is used for higher natural frequency applications. The LA-700 with its compensated fluid damping is designed for lower natural frequency applications. Write for Bulletins LA-600 and LA-700 to Minneapolis-Honeywell, Boston Division, 40 Life Street, Boston 35, Mass.

Honeywell

Military Products Group

WHO'S WHERE

(Continued from page 23)

Changes

Litton Industries' Maryland Division, College Park, Md., has announced the following appointments: **Irving H. Young,** manager of engineering administration; **Fred E. Burnham,** manager-antenna and microwave section; **George Tinker,** director of sales.

Robert G. Yeamans, assistant to the manager of F-108 Rapier weapon system, Los Angeles Division, North American Aviation, Inc., Los Angeles, Calif.

Frank Steinebrey, program director-USAF ultra-high power transistor project, Pacific Semiconductors, Inc., Culver City, Calif.

Samuel W. Stewart, director of engineering and research, Gabriel Electronics Division, the Gabriel Co., Needham Heights, Mass. Also: **John S. Hall,** manager of manufacturing.

Claude V. Hawk, divisional director of reliability, Harrison Radiator Division, General Motors Corp., Lockport, N. Y. **Robert F. Caughill** succeeds Mr. Hawk as assistant chief engineer.

S. A. Beardsley, manager of product information, General Electric's Rocket Engine Section, Evendale, Ohio.

James L. West, director, Link Aviation's Binghamton Laboratory, Binghamton, N. Y.

Norman J. Regnier, marketing director-solar products, Semiconductor Division, Hoffman Electronics Corp., El Monte, Calif. Also: **Howard Mann,** production manager; **Irwin Rubin,** chief manufacturing engineer; **William Parker,** personnel manager; **Emory Glancy,** plant engineer.

Heinz Hanau, director of engineering and research, Industrial Tectonics, Inc., Western Division, Compton, Calif.

G. Norris Shaw, Washington, D. C., representative for Hughes Tool Co.'s Aircraft Division, Culver City, Calif.

H. Wyman Howard, manager of military requirements, Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc., Waltham, Mass. Also: **Thomas E. McCarthy,** public relations manager for the division.

Glenn N. Hackett, director of purchases and traffic, Thompson Ramo Wooldridge, Inc., Cleveland, Ohio.

Richard Fowler, purchasing agent, Ground Support Equipment Department, Hamilton Standard, Division of United Aircraft Corp., Windsor Locks, Conn.

David T. Newman, head of the newly established West Coast technical office, Hollywood, Calif., of the Fairchild Astronics Division of the Fairchild Engine & Airplane Corp.

Dr. Lauriston C. Marshall, associate technical director of Varo Mfg. Co., Inc.'s Microwave Power Laboratory, Garland, Tex.

George H. Kunstadt, technical director, Ground Support Equipment Department, The Martin Co.'s Baltimore, Md., Division.

Thomas L. Phillips, assistant manager, Missile Systems Division, Raytheon Co., Waltham, Mass.

F. D. Olivo, sales engineer-landing gear department, Aviation Products Division, Goodyear Tire and Rubber Co., Akron, Ohio.

How Quaker Thermoid made ground-refueling hose to meet toughest government specifications

1. Developed a tube compound that can carry all aircraft fuels without showing appreciable signs of swelling or loss of adhesion to the carcass. A tube that withstands constant bending, twisting, and flexing without ply separation. Performs well in the range −40°F to +130°F.

2. Developed a tube reinforcement that is lightweight for easy handling and storage, yet able to withstand extremely high pressure without bursting. Resists weather, mildew, rot, and oil.

3. Developed an abrasion- and oil-resistant cover compound that protects the tube and reinforcement from damage when the hose is dragged over concrete aprons.

4. Completely bonded all component parts by an exclusive process of curing and manufacturing to provide a ground-refueling hose that is not only strong and easy to handle, but the safest ever built.

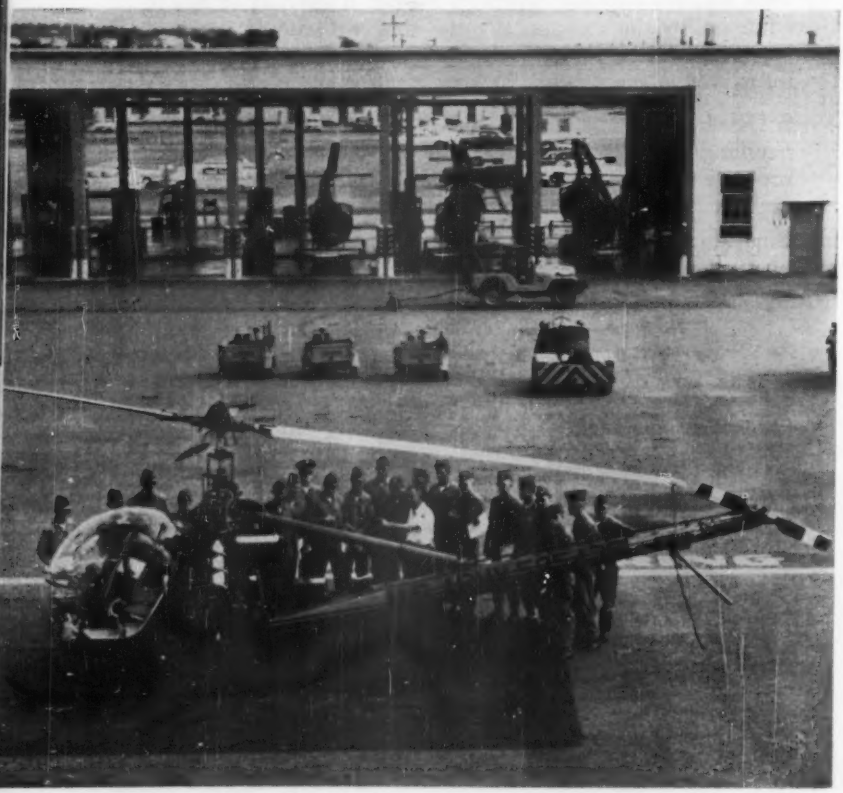
Get complete information on Thermoid-Quaker ground-refueling hose from your local Thermoid industrial distributor, or write *Thermoid Division, H. K. Porter Company, Inc., Tacony & Comly Sts., Philadelphia 24, Pa.*

THERMOID PORTER DIVISION

H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Specialty Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H. K. PORTER COMPANY de MEXICO, S. A.; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

CAMP WOLTERS' Hiller H-23s pass through four maintenance docks in post-flight inspection. Four men plus flight chief are at each dock. Note ladder for servicing rotor area.



HELICOPTER MAINTENANCE buildings were originally designed for overhaul of heavy Army vehicles. Each hangar has 22 doors. Helicopters are towed by Jeep in one side and out the other.

MAIN HELIPORT at Camp Wolters, Tex., is in instant reach detailed records of every Hiller

Civil Company

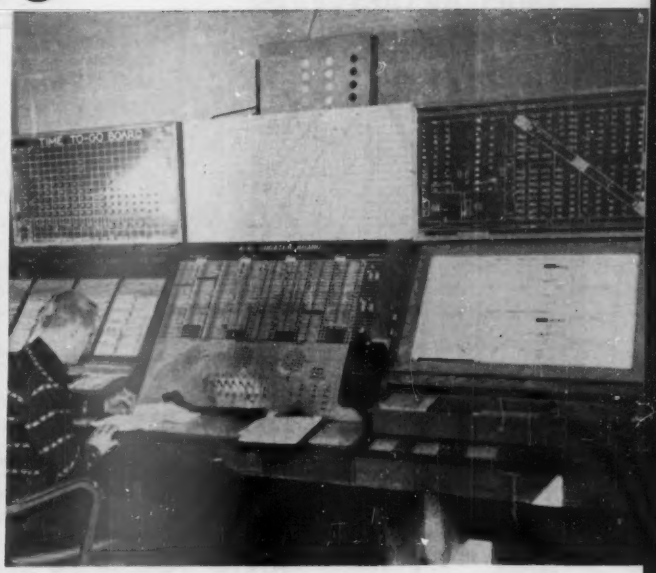
By Erwin J. Bulban

Mineral Wells, Tex.—Working against a schedule that takes no account of time lost due to weather or holidays, the civilian contractor-operated U. S. Army Primary Helicopter School here at Camp Wolters recently passed the 200,000 flying hour mark in some two and a half years of operation without a fatality.

A corps of only 420 employes of Southern Airways Co., teamed with a supervisory Army headquarters staff, operates an average of 215 Hiller H-23B, C and D Raven helicopters on a training mission that graduates nearly 1,000 rotary wing pilots annually from the largest facility of its kind in the free world.

Further pointing up the effectiveness of the training curriculum here is the fact that the civilian-operated school has maintained its safety record while accomplishing over a half-million practice emergency touchdown autorotations.

Monthly flying time, in the six months through Aug. 1, 1959, has averaged 7,377 hr. on the basis of 184 aircraft assigned. Number of aircraft fluctuates due to phase-out of H-23B and C and concurrent phase-in of the H-23D. The school's former fleet of 178 H-23Bs and Cs is gradually being replaced with 130 H-23Ds to reduce maintenance and operations costs and improve aircraft availability rate. Currently there are 81 H-23D models op-



shown in aerial view (left), looking west. Maintenance control board (right) is nerve center of all maintenance operations. One man has with-H-23 helicopter based at Camp Wolters and also the precise location of every aircraft and its maintenance status.

Trains 1,000 Helicopter Pilots Annually

erating at Camp Wolters; the fleet changeover is expected to be completed by the end of the second quarter of Fiscal 1960.

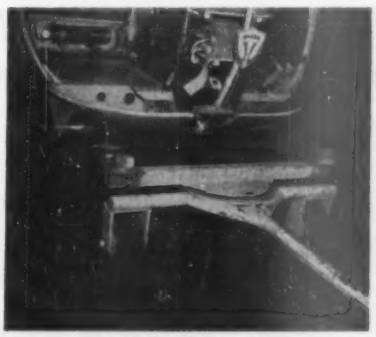
Civilian contract military training and maintenance is big business for Southern Airways Co.—totals some 60% of its gross, Board Chairman Frank Hulse told AVIATION WEEK. The Camp Wolters contract is worth some $2.4 million and runs through June 30, 1960, plus a year's extension.

Company's Enterprises

Enterprises of the company run the gamut from Southern Airways, Inc., a scheduled certificated airline covering nine southeastern states, includes a prime Beech aircraft distributorship for a large part of the south, based at Atlanta, Ga., a nationwide aircraft brokerage service (total aircraft sales for the company ran to $3 million last year), operation of a primary flight school for U. S. Air Force at Bainbridge, Ga., first to incorporate the twin-jet Cessna T-37A trainer in primary school operations, a test and development contract for the Army at Ft. Rucker, Ala., and a subsidiary, Big States Industries, Inc., at Mineral Wells Municipal Airport, that performs repair and overhaul of Army helicopter transmissions and liaison aircraft and helicopters.

To staff the new Camp Wolters operation, a nucleus of key persons was transferred from the Bainbridge school, including Raymond L. Thomas, who became general manager; Ramsey Horton, materiel director; Wayne Schwalm, maintenance director, and Joseph Shields, training director. Hulse's philosophy has been for the selected executives to set up the operation and run their own show. Thomas has put together a tight, economical operation; a glance at the Wolters organization table shows only 10 persons in administrative positions, making for considerable first-hand contact of day-to-day work.

Wolters' primary mission is to run two classes of students through the school—a 16-week curriculum called Officer Rotary Wing Aviator Course (ORWAC), composed of candidates with no previous helicopter experience, who go to Phase II training at Ft. Rucker after graduation—and a 10-week period, Officer Rotary Wing Qualification Course (ORWQC), which handles commissioned officers who are rated fixed wing pilots, who return to their units as qualified rotary wing tactical pilots.



SCREW-TYPE CLAMPS lock Jeep-drawn dolly devised by Southern Airways onto forward cross-bar of Hiller H-23 skid landing gear.

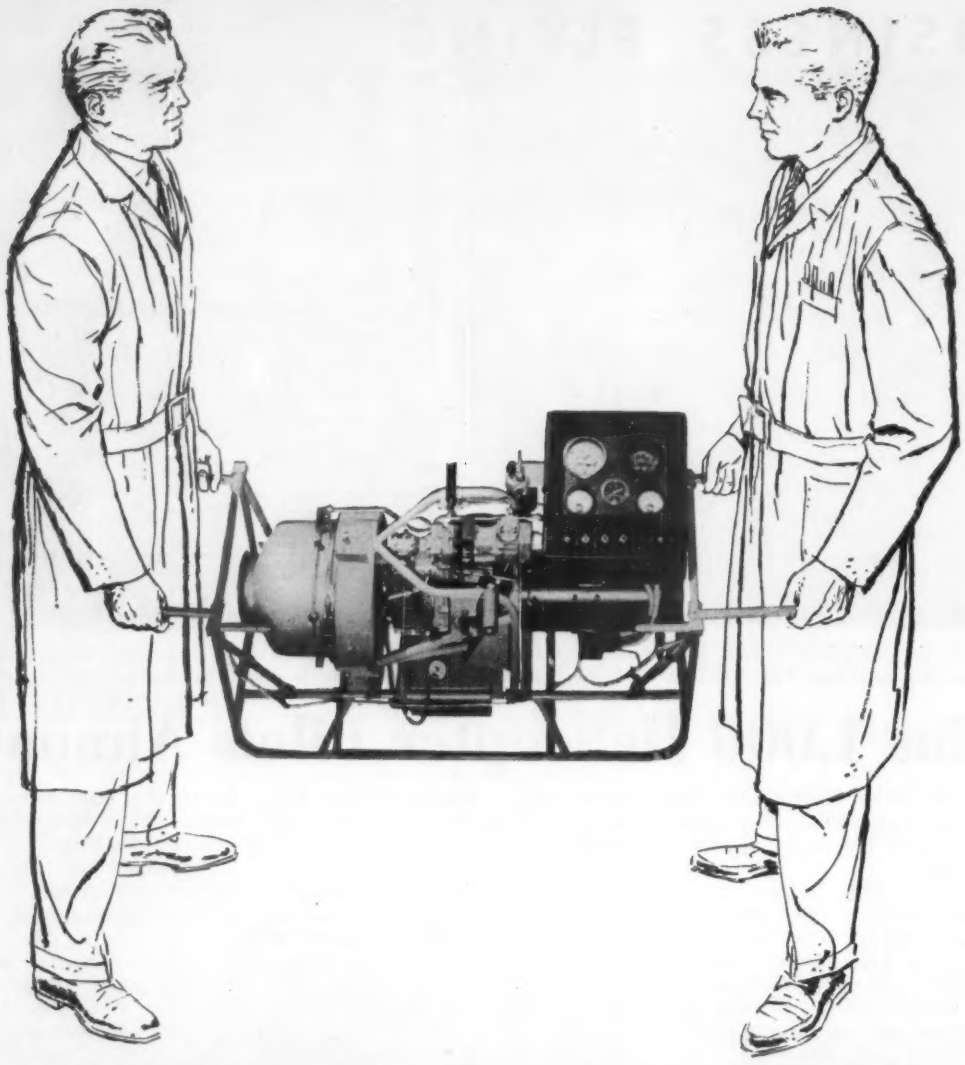
Phase II training at Rucker for the first category of students consists of 14 weeks of tactical helicopter flight instruction and transition in light transport type rotary wing aircraft, then are assigned to helicopter units in the Army.

ORWAC Curriculum

The ORWAC curriculum includes 85 hr. of maintenance, 15 hr. of aerodynamics, 9 hr. of flying safety, 41 hr. of navigation, 32 hr. of weather training, 12 hr. in radio work, with a maximum flying time of 111 hr., of which 51 are solo.

The ORWAC students get 60 hr. of maintenance, 12 hr. of aerodynamics, 2 hr. of flying safety and put in 70-80 hr. of flight time, of which about half is solo.

Camp Wolters expects to start classes for enlisted men, as warrant officer candidates, this fall. Previous experience with enlisted men training in helicopters showed a high proportion being washed out due to lack of motivation, compared with the officer rate, school personnel noted. Attempts to develop patterns for this disinterest were unsuccessful. Actual reason for previous dis-



PORTABLE 45 KW!

New 90 lb gas turbine ideal generator drive for missile support—industrial uses

SOLAR'S REMARKABLE NEW *Titan* gas turbine-driven generator can be installed in a fraction of the space of comparable diesel-powered sets. It is simple in design, easy to maintain, can be started by hand or electrically, reaches full load in seconds—without warmup! And lightweight, portable *Titan* generators can be operated efficiently on a wide variety of fuels.

Solar's *Titan* gas turbine is one of the smallest engines of its type ever built. Only 21 inches long and less than 13 inches in diameter, the 80 hp unit is available in both constant-speed and variable-speed models for a wide variety of applications.

Today, proven-in-service Solar gas turbines—ranging from 50 to 1100 hp—are creating new standards of performance and reliability in missile ground support, electric power generation, boat propulsion and elsewhere. For information, write to Dept. G-143, Solar Aircraft Company, San Diego 12, Calif.

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DES MOINES

ENGINEERS WANTED! *Challenging projects, unlimited opportunities with Solar. Write today!*

European Lightplane Market

Geneva, Switzerland—Indications are that in approximately two years there should be a marked upswing in European business flying as a result of growth of the common market in Europe, Michael G. Neuberger, export manager of Beech Aircraft Corp., told Aviation Week here recently.

Neuberger sees the European common market in full swing in about that time, with business flying growth following the trend (AW May 4, p. 157). Germany, in Neuberger's estimation, is the key to the European market as a whole, but Portugal, Austria, Italy and Sweden are becoming increasingly important as far as lightplane sales are concerned. He also predicted that within a few years Spain will emerge as another promising market, now that it is opening up economically to the rest of Europe. European trend in business flying is toward twin-engine aircraft, capable of flying much longer distances than at present, particularly over the Alps, he noted.

continuance of these classes, however, was because Army reached its authorized warrant officer strength in this category and had to suspend further entries.

In addition to U. S. military personnel, small numbers of foreign military officers and U. S. government agency personnel, such as Forestry and Agriculture, go through the Camp Wolters course.

For about three years ROTC students who have been in the upper half of their senior year have been eligible for 35 hr. of helicopter flight training and 50 hr. of ground school, and Wolters has had 450 students come out of this source. Attrition rate of ROTC students has been lowest of any type, averaging about 8% compared with a normal over-all average attrition of 25%.

Two of the prime departments in such an organization are supply and maintenance. And to keep both functioning with such a low number of personnel, Southern Airways relies heavily upon an array of electronic data processing equipment. Included in this International Business Machines' lineup are: 514 reproducing punch, 002A accounting machine, 602A calculating punch, 082 sorter, 85 collator, 548 alphabetical interpreter, and 024 key punch and a transceiver.

Keeping Track

With this equipment, Southern Airways can keep day-by-day track of every facet of the operations, watch all stock transactions and at the same time maintain lowest safe inventories, thus saving considerable money by minimizing the amount of materiel needed in the pipeline and stockrooms. As the largest training facility of its kind, Wolters' Hiller helicopter operational experience has been invaluable both to the Army and the manufacturer—data processing equipment makes it possible to run rapid analyses of any component in these aircraft. For example, machine analysis permits Army, the manufacturer or the Wolters maintenance department to get breakdowns of aircraft histories by individual ships by serial number, or total discrepancies by type of discrepancies for any one aircraft or the entire number of any model and comparative data with other models.

Much of the data that has been available from Wolters on its experience with the H-23B and C models has been of material value in development of the new D model and is one reason why the school expects to improve its approximate 60% aircraft availability record to at least 70% when it has an all H-23D fleet.

Machines Invaluable

Machines are invaluable in maintaining and requisitioning parts. Wolters maintains a stock of some 965,000 parts, with inventory valued at approximately $1 million. Every 30 days there is a turnover of from $600,000 to $800,000 worth of parts and some 800-1,000 line item transactions daily. With previous manual systems of handling orders, the best a girl could do was 175-225 transactions daily. So the company employed four girls to handle this duty, at a total salary of approximately $1,150 monthly; today, with its IBM equipment, one machine renting at $1,000 per month can handle 600-700 transactions per minute.

Transceiver connects Wolters directly to Army's Transportation Maintenance and Supply Command, St. Louis. Requisitions are coded directly over the line from Wolters' IBM cards; St. Louis' automatic data system scans the request, then checks its own inventory and if the parts are not immediately available, the automatic scanning continues to check the situation at various Army depots around the country. Closed-loop automatic requisitioning system makes it possible for Wolters to receive items in 19 days compared with 43-48 days previous to introduction of machine systems.

This holds if the parts are stocked; there are times when, due to budget problems, requests have to go to the

CHOOSE REDA PUMPS FOR YOUR AIRCRAFT REFUELING SYSTEMS!

VISCOUNT refuels at Tulsa Municipal Airport using Reda Jet-Fuel Submergible Pumps.

REDA **Jet-Fuel** Submergible Pumps Give These Important Advantages:

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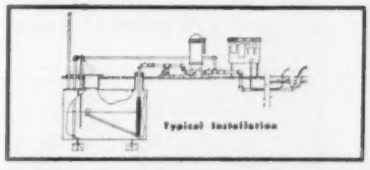
- **No Stuffing Boxes To Leak** — motor & pump in one unit.
- **High Volume at Required Operating Heads** — Models from 1 to 150 HP — capacities to over 1000 GPM.
- For single or double hydrant systems, tank truck and test stand refueling systems.

Illustrated is a typical Underground Storage and Hydrant Refueling System with Reda Jet-Fuel Submergible Pumps, used by Continental Air Lines. This system uses two storage tanks and two Reda pumps feeding into a filter and hydrant refueling system. *It has proved to be less expensive in both installation and maintenance than a conventional tender system would have been.*



Contact Reda Today For Submergible Pumps Especially Designed To Meet The Exacting Requirements Of Aircraft Refueling Systems.

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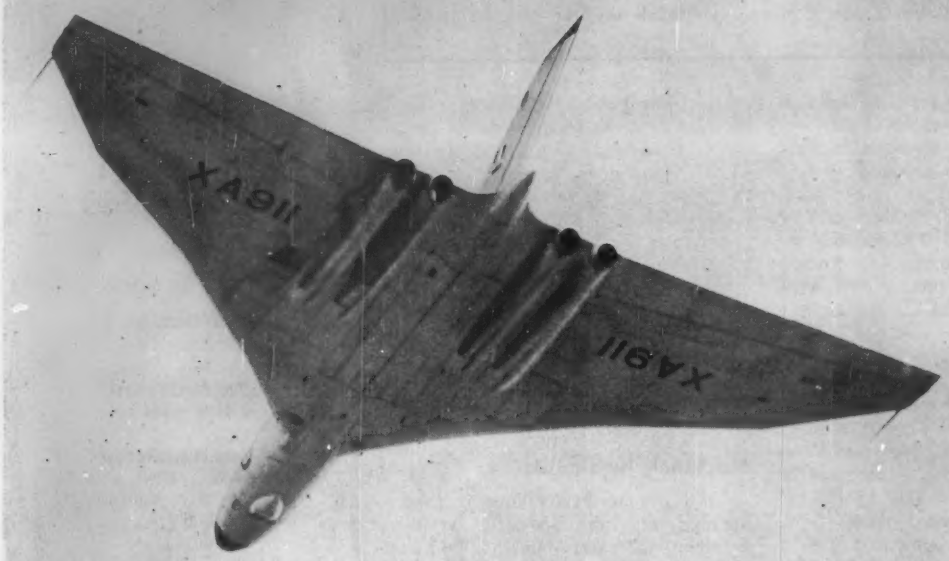
'V'-bombers fly 10 miles a minute, 10 miles up for 10 hours...



...AND BRISTOL SIDDELEY

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce two outstanding high-thrust turbojet engines—the Olympus and the Sapphire.

Between them these two engines power the most potent part of the RAF's strategic V-bomber fleet. The Olympus which delivers 17,000-lb thrust dry (24,000 lb with reheat) powers the Avro Vulcan. The Sapphire powers the Handley Page Victor. These engines give the V-bombers supersonic capability—long range —great altitude—superior performance to any other aircraft of their type in the world.

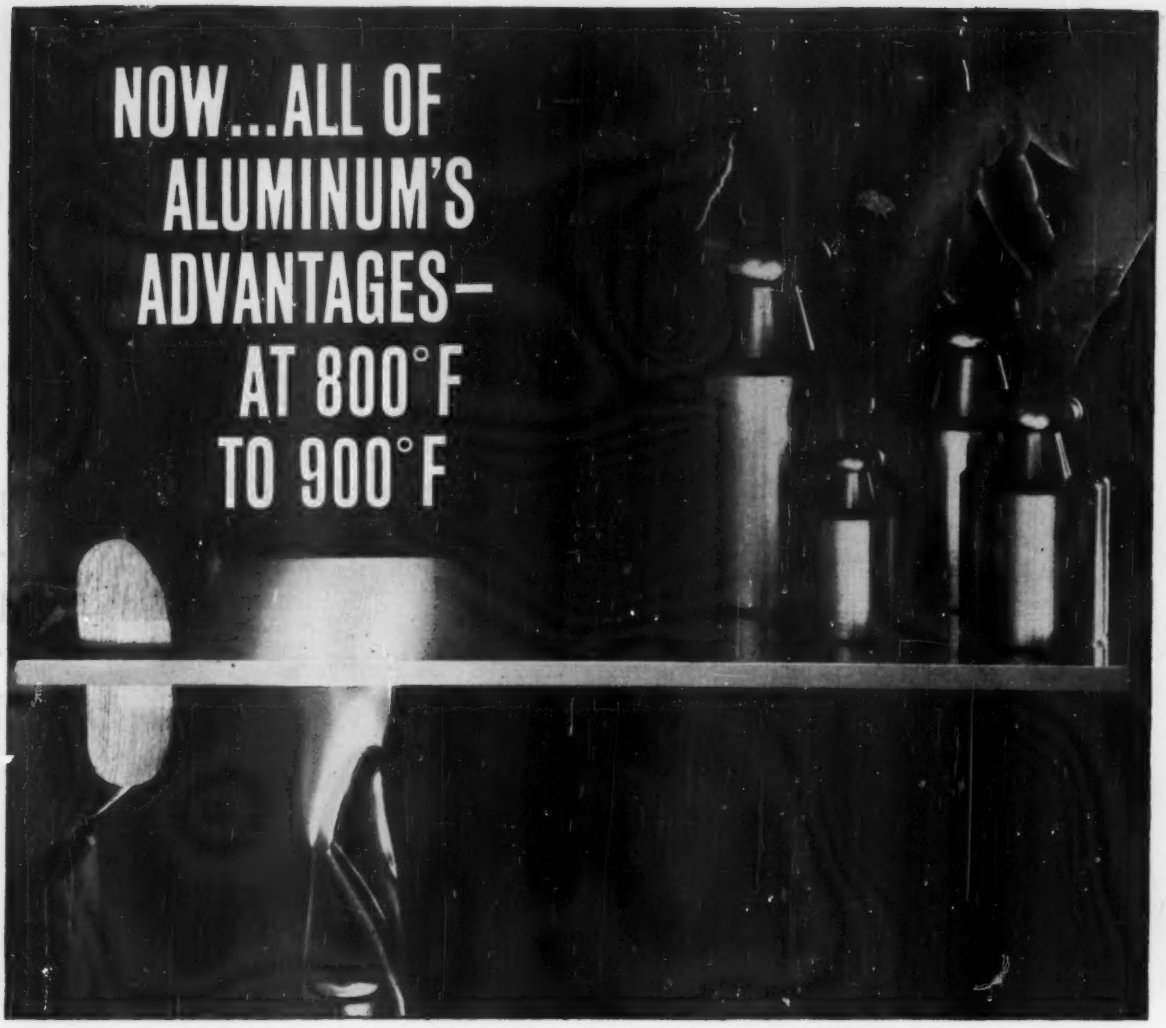
BRISTOL SIDDELEY ENGINES LIMITED

SUPPLY THE POWER

The Bristol Siddeley Proteus powers the Britannia airliner. Four Proteus give this 130-seat aeroplane a speed of over 400 mph—a range of over 5,000 miles. Britannias are in service with ten airlines and with RAF Transport Command.

The Star Sapphire car is powered by a Bristol Siddeley 4-litre engine. Combining great power with exceptional quietness and luxurious comfort, the new Star Sapphire has a top speed of over 100 mph and an outstanding all-round performance.

Bristol Siddeley Viper turbojets range from 1,640—3,000-lb thrust. Vipers power the Australian Jindivik, the Hunting Jet Provost, the Italian Macchi MB 326 (illustrated), and have proved their supersonic capabilities in mixed powerplant fighters.



New Aluminum Powder Metallurgy Products Open New Application Horizons

THE TRADITIONAL advantages of aluminum—at temperatures up to around 500° F—can now be extended to temperatures hundreds of degrees higher than conventional aluminum can take.

THANKS TO Alcoa's pioneering with the metallurgical technique known as "dispersion hardening," solid aluminum products reformed from *powdered* aluminum by heat and pressure take on new qualities. They are fine-grained, hard, tough, sapphire-like in brilliance, and amazingly resistant to heat effects.

ALUMINUM POWDER metallurgy products—"APMP" for short—are available in a family of four alloys. They are usually extruded into forms which can subsequently be further extruded, rolled, forged, drawn or impacted by conventional metal-working methods. Where you need the properties of aluminum, but where temperatures seem "too high" for conventional aluminum products, chances are that one of these four alloys may solve a host of hectic problems.

NATURALLY, there's more to the story than we've been able to pack into this limited space. If you'd like to know more, please write for our free booklet, *Alcoa's Aluminum Powder Metallurgy (APM) Alloys.* Aluminum Company of America, 2026-J Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM

Your Guide to the Best in Aluminum Value

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays NBC-TV

Here's how Alcoa helps you design and make it...

You get more than just 16 ounces of metal in every pound of Alcoa® Aluminum. Here are eight important unmatched values that go with it:

1. **Research Leadership,** bringing you the newest in alloys and other applications.
2. **Product Development** by experienced specialists in your field of interest.
3. **Process Development Labs** for aid in finishing, joining and fabricating.
4. **Service Inspectors** to help solve production problems in your plant.
5. **Quality Control** to meet demanding standards and to match your special needs.
6. **Availability,** channeled through the nation's best-stocked aluminum distributors.
7. **Factory-Trained Salesmen** for vital, on-the-spot information.
8. **Sales Administrators,** constantly on call to service your orders.

Complete line of commercial aluminum in all forms, alloys, gages, tempers and job shop services.

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INGOT AND PIG • SHEET • PLATE
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SCREW MACHINE PARTS

JOB SHOP
FORMING • WELDING • FINISHING
FABRICATION AND ASSEMBLY

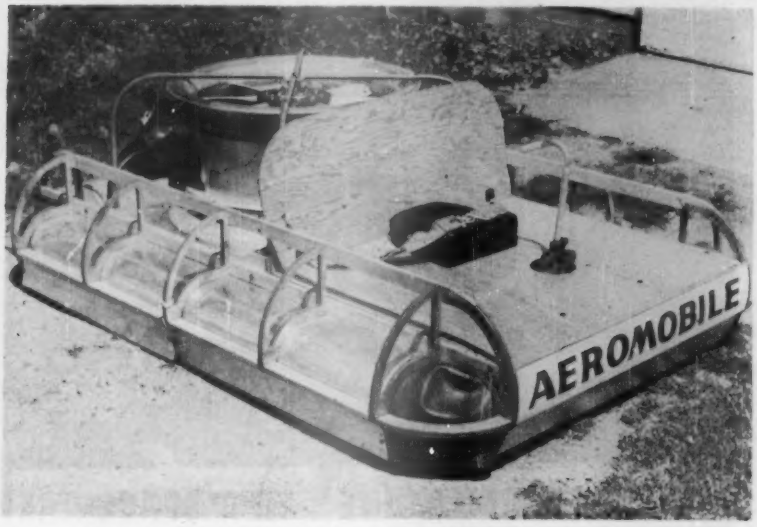
ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

manufacturer. This is also the case with some long lead items.

Generally, in event of some hold-up, Wolters resorts to temporary cannibalizing to keep the aircraft flying. There have been times when parts arrive just in time to prevent a large-scale grounding.

Nerve center of Wolters' maintenance operation—largest on the Table of Organization—is a small office near the main field control tower with intercommunication tie-in to all shops and by radio to vehicles. Key feature here is a consolidated data board developed by the civilian contractor that provides maintenance control with an hour-by-hour record of where every aircraft is and the workload in every shop. Detailed records tell to the minute when every aircraft must have periodic checks and scheduled maintenance. A record of every aircraft in the fleet, by serial number, is kept to record status of all components in each ship, so that the control center can schedule each shop's workload to prevent overloading and delays, also shift personnel around to meet loads.

When aircraft come out of the shops the control center allocates them their parking spots on the ramp. Visual track is available at all times of all aircraft by use of small magnets, each representing an H-23. A Time To-Go Board provides a constant record of the number of hours each available aircraft has left before it has to go into the mainte-

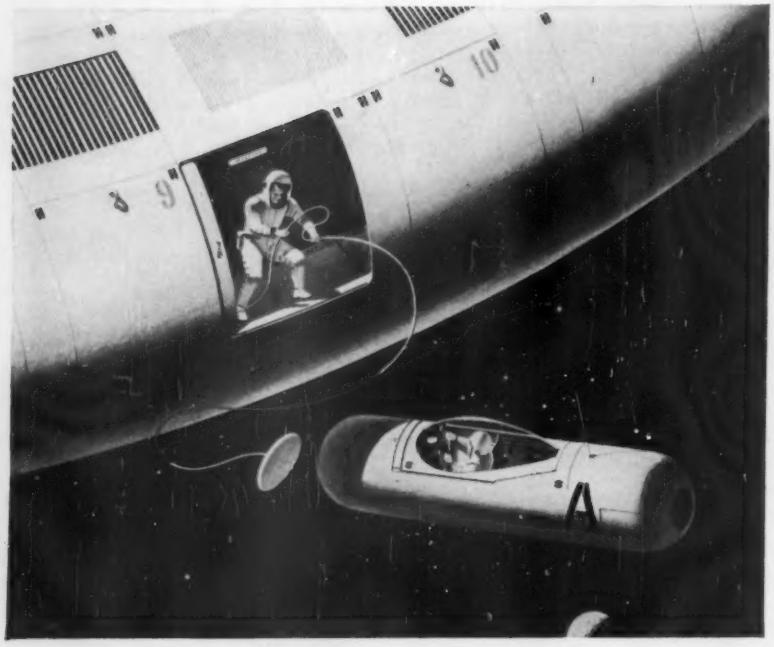


'Do-It-Yourself' Aeromobile Starts Tests

One of the latest in the fast-growing family of ground effect vehicles is this single-place Aeromobile, designed and built by William Bertelsen, Neponset, Ill., who claims a top speed of 40 mph. at six-inch altitude for his McCulloch 72-hp.-powered vehicle. Propulsion is supplied by an eight-blade maple-wood fan mounted behind the cockpit. Construction is primarily of aluminum sheet, marine plywood and spruce. Bertelsen estimates the total cost of materials at $100 and cost of a new engine at $1,325. Cost of having necessary parts and fittings machined is estimated at $200. Aeromobile dimensions are: Length, 8 ft. 5 in.; width, 5 ft. 1½ in.; height, 2 ft. 8 in. Gross weight is 583 lb., the empty weight of the vehicle is 408 lb.

COUNT DOWN

for the conquest of space



WHAT KIND OF ENGINE FOR A SPACE-TAXI?

It takes a unique engine to jockey a space-taxi in for a landing on an orbiting space station—one that will give a space pilot instant control and precise maneuverability.

Such an engine is the fully controllable rocket engine—ideal for space travel yet as easy to operate as an automobile engine.

The rocket engines are ready now

Although the space-taxi is still a gleam in an engineer's eye, the controllable rocket engine is available now...and has immediate application for existing aircraft. The pilot of a plane with auxiliary rocket power can switch it on for sudden, swift acceleration at high altitudes . . . the aircraft's air-breathing turbojets supplying power for ordinary flight operations. This is the mixed-power theory. Since World War II several mixed-power concepts have been developed in foreign countries, including Russia, France and England.

Extra power for today's aircraft

Rocketdyne already has designed, tested, and manufactured rocket engines for mixed power applications. The AR-1 rocket engine is a liquid-propellant system, as are the large power plants for the Atlas, Thor, Jupiter, and Redstone ballistic missiles. The AR-1 passed stringent flight tests as a supplementary power plant on modern jet aircraft. Substantial improvements over normal near-sonic speed and 50,000-foot altitude capabilities were demonstrated in more than 100 test flights.

The AR-2, second in a series of four rocket-engine models developed by Rocketdyne, is a fully-throttleable engine that provides varied thrust. Using fuel from the airplane's tanks —which automatically ignites with hydrogen peroxide—these engines have full stop and restart capability.

More value for taxpayers' money

The auxiliary rocket engine gives present aircraft superperformance capabilities at a relatively low cost. It provides the increased speed and maneuverability that could spell the difference between the success or failure of an intercept mission. Almost any existing jet aircraft, as well as those now on the drawing board, can be adapted readily for AR engines.

Looking forward to tomorrow

Beyond a doubt, rocket power has a leading role in the Free World's future. Rocket-propelled airplanes, such as the X-15, will pave the way for man's entry into Outer Space. The multi-million-pound-thrust systems that are now under development at Rocketdyne will be man's means to explore interplanetary Space. But meanwhile, these rapid advances in rocketry can add great strength to America's present deterrent arsenal.

THE MEASURE OF ROCKET POWER

The liquid-propellant AR rocket engines are "static tested" at Rocketdyne's field laboratory to measure thrust and performance.

FIRST WITH POWER FOR OUTER SPACE

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

nance shops. Everything is tied to records detailing the hours each part has before check, overhaul or replacement. H-23B and C are given periodic inspections every 50 hr., the H-23D every 75 hr.

The three large buildings used for helicopter maintenance originally were designed and built for overhaul of heavy Army vehicles used by former occupants of the post. With 22 doors on each long side and large entrances at either end, they are considered ideal for rotary wing work. About the only modification necessary was installation of monorail equipment where needed.

One building handles post-flight maintenance work, with a shift of 32 people starting at 5 p.m. and working until 1:30 a.m. Setup for handling post-flight work provides four docks, with a flight chief in charge of each. Each dock has two Jeep tugs assigned to it; as one tug tows away a completed aircraft across the hangar and out to the fueling truck, the second tug brings in another H-23.

Four men are assigned to each dock; as soon as the tug stops, one goes to work and polishes the bubble canopy inside and out with glass cleaner, airhoses all dirt out of the cabin and empties the ash trays; one mounts each side of the rotor shaft, greases all bearings and checks and wipes clean all external parts, another checks the tail rotor assembly and aft fuselage, also wiping all external surfaces clean. All the men, except the bubble polisher, rotate their positions around the ship each night to break the monotony and to develop familiarization with all of the aircraft. The same aircraft go through the same docks each night so the men stay familiar with each ship's characteristics and can keep personal track of problems.

The aircraft book is checked for recorded discrepancies—if work is too much to be done by the post-flight crew, the ship is assigned to a 12-man "graveyard" shift, on from midnight to 8:30 a.m. This system permits moving approximately 85 aircraft through their post-flights each night shift, each ship taking approximately 20 min.

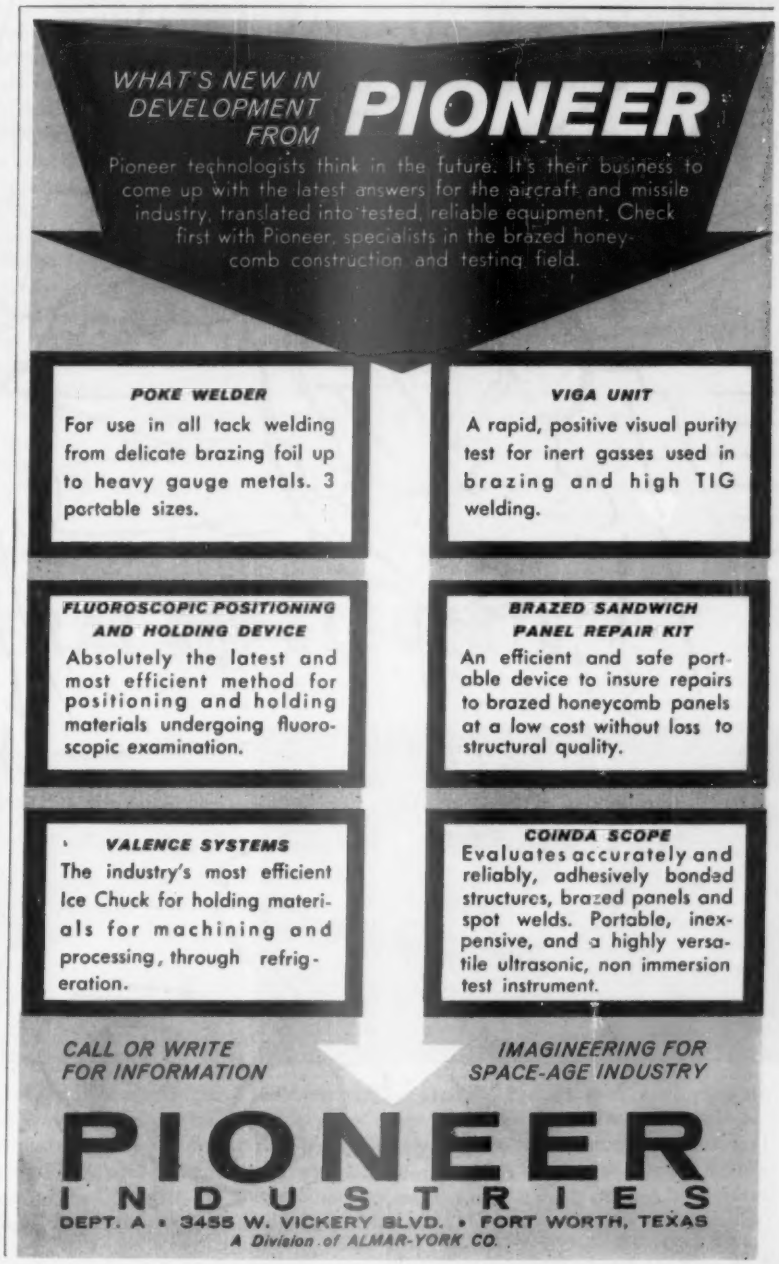
Post-flight shift also has responsibility for watching over aircraft assigned to night flying at stage fields. A mechanic is assigned to stage field with a grease gun, oil cans and a special box containing approximately 50 parts that experience has shown are most frequently needed, such as spark plugs.

Periodic maintenance works two shifts: from 6 a.m. to 2:30 p.m. and 2:30 p.m to 11:00 p.m.—this two-shift system permits completing a periodic in one day. A periodic normally takes from 45 to 48 man-hours.

Southern Airways' maintenance group has gotten the ratio of man hours on the ground to aircraft flying hours down to 4.3, this including everything done by anybody in the maintenance area. Line maintenance—so-called user maintenance—is down to 1.5 hr. per flying hour, AVIATION WEEK was told.

Facility at Wolters is capable of handling maintenance from first through fourth echelons—fifth is handled by Army depots. Field maintenance facilities include blade shop, sheet metal, engine, radio, carpentry, paint and teardowns. Capability is pointed up by the fact that once when Southern personnel couldn't obtain replacement tail booms for H-23s, they located some in a depot that they completely rebuilt on the field.

Maintenance personnel through various echelons at Wolters consider the new H-23D model the answer to the student helicopter training problem, primarily because it incorporates the lessons learned in the hard operational grind at this station. Thus far, the aircraft's designed capability of going 1,000 hr. before major overhauls has been progressing satisfactorily, although Wolters has not reached this time on any of its H-23Ds. Some attained 750 hr., were stripped and components judged capable of reaching the designed goal. Several H-23Ds are now at about 900 hr. without requiring a major overhaul.


WHAT'S NEW IN DEVELOPMENT FROM PIONEER
Pioneer technologists think in the future. It's their business to come up with the latest answers for the aircraft and missile industry, translated into tested, reliable equipment. Check first with Pioneer, specialists in the brazed honeycomb construction and testing field.
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General Electric puts the

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fan AFT for
OF INSTALLATION

Because the fan is aft on General Electric turbofan engines, airframe designers have a choice of several efficient installation arrangements. The aft fan engine lends itself readily to a combined engine-fan inlet, cheek inlet aft for fan air, or full annular inlet aft for fan air. All three types allow excellent accessibility to the engine, and can be used with pod or internal fuselage installations.

The main engine portion of the aft turbofan uses operationally proven hardware designs. The same excellent characteristics of General Electric's other high-performance variable stator engines, like the J79 and CJ-805, are retained in the aft fan engine. The basic engine's high capability for handling inlet distortion is actually exceeded by that of the aft fan.

G-E aft fan engines use thoroughly proven accessory drive system arrangements. Their low silhouette and in-line arrangement minimize frontal area and assure an efficient flow of fan inlet air.

Thrust reversal of aft fan engines is simplified by the aft fan's single-plane exhaust. A single reverser handles both main engine and fan exhaust streams. Counter-rotation of fan rotor and the main rotor decreases gyroscopic loadings, cutting the required weight of the aircraft mounting structure. Proximity of engine exhaust makes a heavy, complex anti-icing system unnecessary, further reducing installed weight. The aft fan engine's low noise level minimizes acoustic fatigue in surrounding aircraft parts, substantially adding to aircraft durability, and decreasing weight.

When the fan is aft, mechanical simplicity, proven hardware, and nacelle flexibility mean unexcelled ease of turbofan installation. General Electric Co., Cincinnati 15, Ohio. 235-38

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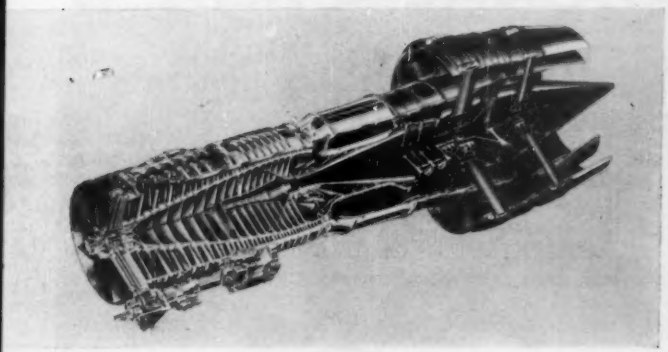
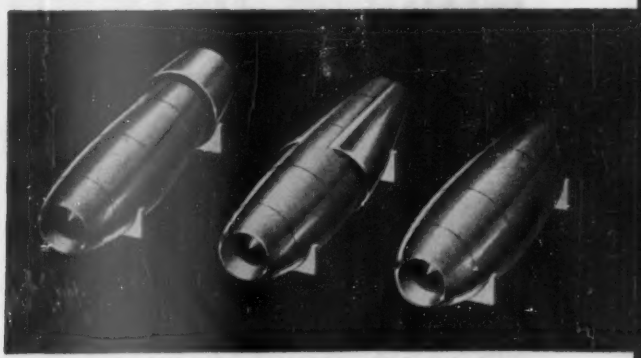


General Electric turbofan engines are more reliable because addition of the aft fan leaves the main engine unchanged. Main engine maturity is retained —lube system, shaft and bearing loads, and control system have accumulated four years of flight experience on military and commercial aircraft.



Aft fan engine nacelle designs may use separate inlets for main and fan air. Two typical examples of this design are the aft annular inlet, and the cheek-type inlet. An alternate design is the combined engine-fan inlet, taking aboard both main engine and fan air at the forward end.

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Esso is clearly the leader. Airlines know that quality saves them money in the long run. Esso Aviation Oils are backed by intensive research, comprehensive service tests and millions of hours of actual use in commercial air transports. In reciprocating engines, Esso oils prevent piston ring sticking and lessen the formation of sludge and other harmful engine deposits. With an unusually high viscosity index, Esso Aviation Oils maintain fluidity at low temperatures yet provide a tough shield when hot. Esso oils can be relied upon to reduce wear of cylinders, bearings and other critical engine parts.

In aviation turbine oils, the synthetic Esso Turbo Oils 15 and 35, perfected more than eight years ago, were the first oils approved for all of the world's most advanced turbine airliners. Both types of oil reduce maintenance costs while increasing the time between overhauls.

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Radford Credits Business Flying For Increase in Company's Gross

Santa Maria, Calif.—Radford Supply Co.'s 10-fold increase in business during the last nine years is unequivocally attributed to business flying by George Radford, president.

Since the purchase of his first aircraft, Radford has flown somewhere between 1,200 and 1,500 hr. in pursuit of new business. He had a "real going business" in 1951, with an annual gross of $250,000 to $300,000, but as a direct result of getting around more rapidly in his aircraft, expects this year's gross to hit $2.5 to $3 million.

"Taking to the air," says Radford, "marks us among customers as a modern, efficient and progressive company. We could not have earned this reputation so rapidly in any other way."

Radford now flys a twin-engine Piper Apache in traveling about the western United States. Apache is the fifth in a series of private aircraft he has owned, starting with a Stinson Station Wagon in 1951, followed in succession by three Beech Bonanzas, each aircraft a little better equipped than its predecessor.

Radford flys the Apache approximately 350 hr. per year calling on distributors and negotiating contracts. Greatest part of his time is devoted to the supply company comprised of Radco Products, Inc., and Radco Manufacturing Co., manufacturers of sliding aluminum windows and doors. He is also president of two other companies devoted to real estate and also recently formed Radco Extrusion Co., Inc., and Radco Screen Products, Inc. Additionally, he is first vice president of the Sliding Glass Door Institute located in Los Angeles.

All of these enterprises make Radford a very busy man and yet the airplane makes it possible for him to spend evenings and weekends at home and even squeeze in a night school course.

Even the fact that his company is now located in Santa Maria is a direct result of the effect flying has had on his business methods. Until November, 1956, the company was located in the Los Angeles area with facilities at three different sites in Burbank. Having established the practicability and economy of business flying, Radford decided to move out of the sprawling Los Angeles complex and into Santa Maria where he could benefit from lower property prices and lower labor costs. Not the least of his considerations was escaping Los Angeles' traffic and smog. Present main plant site is on the Santa Maria Airport which was originally constructed as a training base for Lockheed P-38s during World War II. A taxiway leads to within 20 yd. of Radford's office door.

Reason for selecting this site was that it supplemented his flying activities and buildings could be leased from the city at nominal costs.

Plans for expansion for his business are presently directed toward locating

Schweizer 1-26 Has Design Changes

Schweizer 1-26 sailplane, 100th off production line, has new metal turtle back and plastic tail fairing. Cockpit interior also has been improved. Aircraft was delivered to Antelope Valley Soaring Club, Palmdale, Calif. Sailplane is available in kit form (AW July 14, 1958, p. 98). Wingspan is 40 ft.; aircraft has flown as far as 300 mi.

GEROTOR aircraft pump can handle several different fluids and functions simultaneously

The unique construction of the Gerotor type pump permits aircraft systems designers to combine *several pumping* functions in a single pump housing mounted on a single pad and driven by a single shaft.

Basically a form of internal gear pump, the Gerotor has only two moving parts: an inner toothed element meshing with an outer toothed element. The inner Gerotor has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from the intake to the discharge. (See Fig. 1). The volume of the chamber multiplied by the number of driver teeth and RPM determines the quantity of fluid pumped.

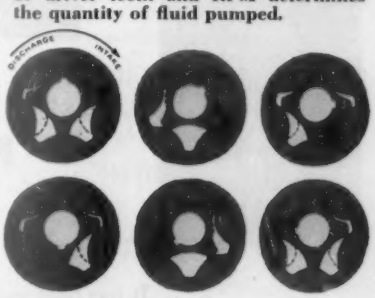

FIG. 1

Both Gerotor elements are mounted eccentric to each other on the same shaft. This structure permits stacking a number of sets of Gerotors along the same shaft, in a common housing. By simply providing each set with a separate compartment and inlet and discharge ports, several fluid systems can be served simultaneously and without interference. (See Fig. 2). Different capacities can be provided for each system despite the common driving shaft speed by varying the diameter or thickness of the Gerotor elements to vary the volume of the tooth chamber.

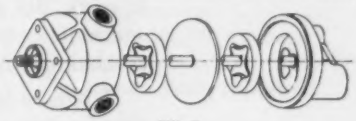

FIG. 2

Diversified systems such as lubrication, scavenging, low pressure hydraulic servo systems and motors up to pressures of about 1000 psi may be centralized in this manner and multiple pump installations avoided.

Advantages – The Gerotor is a positive displacement pump. It is simple and compact, lightweight, valveless, provides high volumetric and mechanical efficiency and offers exceptional performance at high altitudes.

Technical data—is available and your inquiry is invited. Write:

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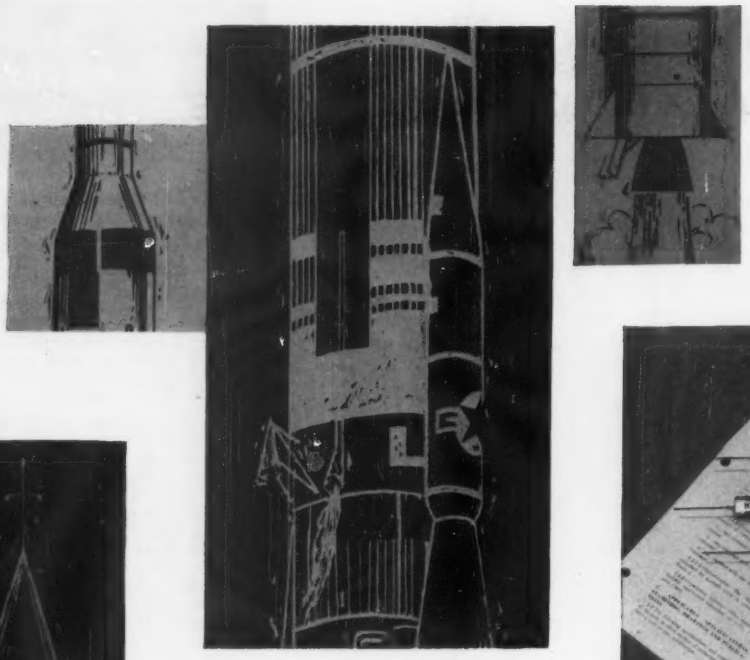

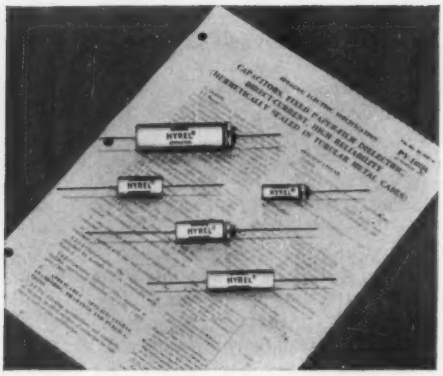

MISSILE-READY CAPACITORS

—thanks to Sprague's PV-100A

It has been more than three years since Sprague originated Specification PV-100–*the first high reliability capacitor specification for missiles and other critical applications.* This specification and a later revision, PV-100A, have proved so comprehensive and so successful in providing "the highest order of reliability known to the capacitor industry" that their provisions are currently reflected in *every* military specification covering high reliability capacitors. This is a distinction shared by no other capacitor manufacturer.

The capacitors manufactured by Sprague to PV-100 and PV-100A standards have amassed a record of reliability far in excess of original expectations. On high frequency vibration, shock, and other environmental tests, failure rate has been almost zero. On accelerated life tests (250 hours at 140% rated voltage, 125° C) *failure rate has been less than .05%.* This performance is virtually impossible to beat . . . now and for some years to come. But Sprague doesn't stop here. The company's research on materials, processes, and controls is now more intensive than ever. Sprague knows that only through continuous research can high reliability be made *higher.*

If you're interested in the fine points of high reliability capacitors, call your Sprague District Office or Representative. Or write letterhead request for Sprague's Hyrel Bulletin 2900A and Specification PV-100A to Technical Literature Section, Sprague Electric Company, 327 Marshall Street, North Adams, Mass.

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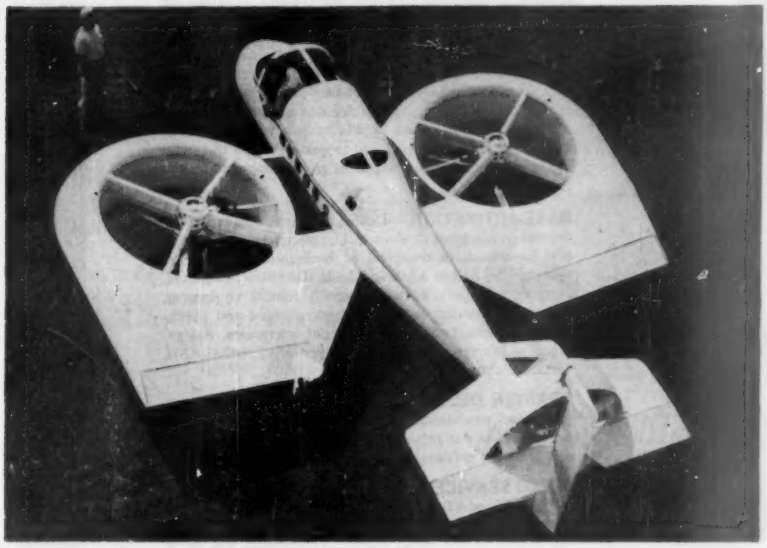
property on abandoned or little-used airfields. Arrangements were recently concluded for leasing a building on a former Navy field near San Diego. Initially this building will be used for warehousing Radford's sliding glass doors and screen products. He plans to open a manufacturing facility at the San Diego site in the near future.

He has examined airport sites in Arizona for additional facilities but has not as yet concluded any firm agreements. Present dependence on aircraft precludes consideration of any site not airport-located. Much of this airport property, located on abandoned military fields, can be obtained at low cost and out of the high tax area of large metropolitan areas such as Los Angeles.

Actual cost of operating the Apache for business purposes works out like this:

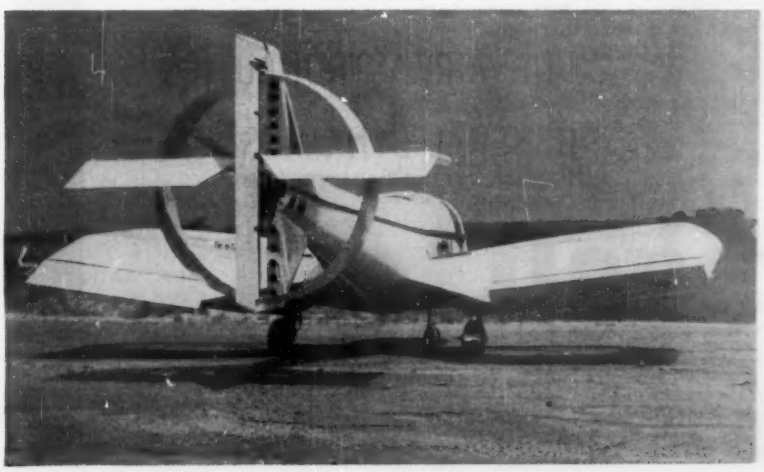
• **Direct operating costs** for fuel and oil are $6.52 per hour. Figure is based on 18 gph. consumption, 42.2 cents per gal. for fuel (6¢ per gal. highway tax is refunded) and, at an average speed of 173 mph., cost per mile is $.044. Oil cost per hour is almost insignificant, since only one quart per engine is added every 33 hr.

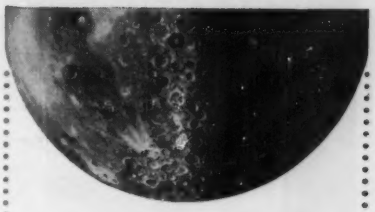
• **Other direct operating costs** are $240 per year for hangar space, $250 per



Vanguard 2C Fan-Wing Undergoes Ground Tests

Vanguard 2C fan-wing vertical takeoff and land aircraft has completed 12 hr. of ground runup tests at Vanguard Air & Marine Corp. plant at Paoli, Pa. Design envisions both military and civil versions (AW May 25, p. 129). Vanguard next will be airlifted by U. S. Air Force to Moffett Field, Calif., for wind tunnel tests at Ames Laboratory. Vanguard 2C is two-place configuration powered by a single Lycoming 0540-A1A piston engine mounted behind the cockpit; wing rotors are three bladed. Engine transmits power to ducted pusher propeller via a shaft about 10 ft. long. Tail duct is 5 ft. in diameter.





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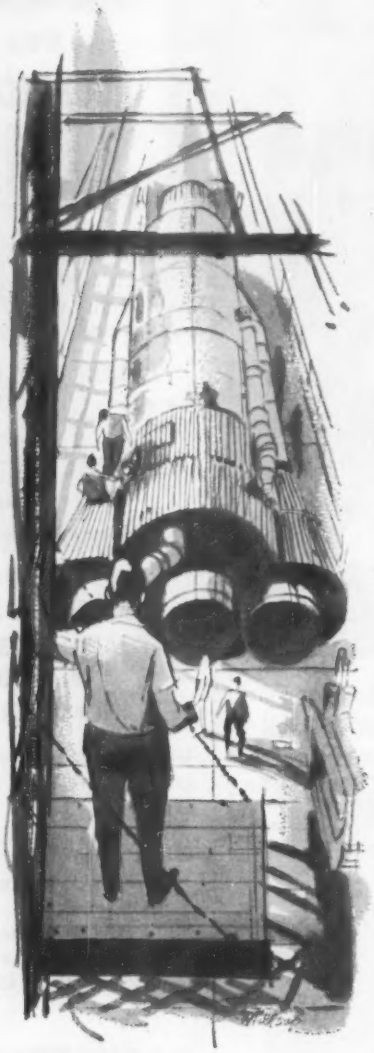

PRODUCT SUPPORT ENGINEERS

URGENCY—SPEED—RELIABILITY. These words describe Convair-Astronautics top-priority program of activating Atlas ICBM bases throughout the United States. Included in this immense task is the job of training Air Force personnel, developing and producing hundreds of technical manuals and providing technical assistance to the Air Force. The Product Support department at Astronautics is responsible for this assignment and to accomplish this, it must double in size within the next two years. Engineers qualified to participate in this long-range program will find excellent growth opportunities in the following areas:

BASE ACTIVATION—Design or liaison engineers with degrees in mechanical, electrical or electronic engineering and experience in electrical or mechanical systems are required for liaison work at missile launching complexes, or design support work on launch control equipment, propulsion systems, automatic programming and check-out equipment, and missile checkout operations. Assignments at Warren AFB, Cheyenne, Wyoming; Offutt AFB, Omaha Nebraska.

TRAINER DESIGN—Trainer Design engineers (electronic and mechanical) with degrees in ME, AE or EE are needed to design simulators to be used in the training of Air Force personnel on the Atlas weapon system.

FIELD SERVICE—Engineers, preferably with degrees in ME, AE or EE and field or in-plant hardware experience are needed to act as technical representatives to the Air Force on the Atlas ICBM. Assignments will be at Vandenberg AFB, Santa Maria, Calif. A field service bonus is authorized for field assignments in excess of six months. Per diem paid for assignments under six months.

Our engineering representatives will be conducting **INTERVIEWS** in major cities soon:

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Qualified Product Support Engineers are urged to send a detailed resume at once so advance arrangements can be made for a confidential interview. Write to Mr. T. W. Wills, Engineering Personnel Administrator, Dept. 130-90

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5620 Kearny Villa Road, San Diego, California

year for periodic inspections, and about $600 per year for hull and liability insurance. This is a total of $1,090 per year, or, based on 350 hr. flying per year, about $3.12 per hr.

• **Total direct operating** cost comes to $9.63 per hr. or slightly less than $.06 per mile.

Initial cost of the Apache was in the vicinity of $42,000, which is at first startling to many small businessmen. Further examination of the tax benefits that accrue to a business aircraft owner reveals that the actual cost to the company is nominal in the long run.

Radford's company pays 52% federal and 4% state taxes. On the purchase of a new aircraft, tax regulations permit depreciation writeoff of one-half the first year, one-quarter the second year and one-eighth the third and fourth years. Therefore, of the initial $42,000 cost, less than $18,500 is borne by the company during the four-year period.

Resale Gains

At the end of four years, operating approximately 350 hr. per year, resale value of the Apache could well be $18,500, judging by the resale value of Radford's previous aircraft. If the aircraft is sold for $18,500, a capital gain tax of approximately $5,000 will be assessed. Latter figure works out to $1,250 per year, or about $3.52 per hr. Adding this hourly cost to the previous figure brings a total of $13.04 per hour total cost or about 7.5¢ per mile.

Another way of judging the economy of business flying is by reckoning the time saving on executive salary. Radford pays himself a salary of approximately $25,000 per year or about $100 per working day. Driving time to San Francisco is approximately 7 hr., to Los Angeles about 5 hr. By comparison, flying time to San Francisco is approximately 1½ hr., to Los Angeles 50 min. Radford frequently works in his office until 10 a.m., flies to San Francisco for a luncheon date with a distributor and is back in his office by 3 p.m. for further work. Carrying out this sort of close personal contact with business associates would not be possible except for air travel. Even commercial airline travel is too restrictive as far as time schedules and frequency of flights are concerned.

One of the most frequently heard objections to business flying is "I'd like to fly but my wife won't let me." Radford's wife is enthusiastically in favor of his business flying and often accompanies him on trips. His wife is a 50% stockholder in his companies and Radford claims she is one of his best salesmen. In reply to a query from a friend at a luncheon one afternoon, Mrs. Radford said she only worries about her husband when the

H. D. Elverum, Supt. of Assembly
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weather is bad, because this means he will drive instead of fly. She concedes that another strong point in favor of flying is that it permits more family life.

The flying bug bit Radford in 1950 when a friend at Glendale Airport soloed him in an Ercoupe. A business trip to Sacramento became necessary coincident with the requirement for a solo cross-country. Radford combined business with pleasure, flew the Ercoupe to Sacramento, thereby completing the cross country requirement and fulfilling the business obligation simultaneously. Trip was made in one day where it had formerly taken two days of hard driving with an overnight stay.

Convinced that it would be an asset to his business, Radford bought his first aircraft, a Stinson Station Wagon, in 1951. Average yearly utilization on the Stinson was only about 50 hr., but this figure has grown through the succeeding Beech Bonanzas to the Piper Apache which now logs about 350 hr. per year.

Dealer Maintenance

Maintenance on Radford's aircraft is always performed by the respective dealer. In the case of the Bonanzas, Beech distributors always did the periodic checks. With the Apache, maintenance is performed by a Piper dealer at Hawthorne Airport in California. Radford's personal feeling is that a distributor or dealer is more apt to know the latest bulletins and maintenance tips on the aircraft than would someone who performs maintenance on different types of equipment.

This maintenance practice has become policy since an incident which occurred on a flight to Seattle resulted in a forced landing for Radford and his wife at Portland, Ore. A mechanic changed oil in his Bonanza and replaced the non-detergent oil with a detergent oil. Result was that carbon deposits clogged the oil strainer, resulting in the engine oil being pumped overboard. Thereafter, maintenance was always scheduled to be done by a dealer in the Los Angeles area. A few hours' stop-over in conjunction with a business trip to Los Angeles is usually sufficient for a periodic inspection; 100-hr. inspections are arranged for when the aircraft can be left with the dealer for two days.

One of the many times when the aircraft saved the day occurred when a newly purchased truck was damaged when a broken fan pulley pierced the radiator. Parts for repairs could only be located at the assembly plant near San Francisco. A telephone call started parts on the way to Oakland Airport while Radford was en route in the Apache. New parts were installed as soon as the aircraft returned to Santa

Sensing .001° angular displacement—

NORDEN'S BRL-5 ANGLE ENCODER

A 4¼-mile crater on the moon, or a table tennis ball at a distance of a mile—these are examples of the extraordinarily acute .001 degree angular displacement which can be sensed and encoded by the BRL-5 Precision Angle Encoding System.

The system is made up of a small, light transducer and an associated electronic encoder which converts angular data into digital language. The transducer is less than ⅓ the size of other angle encoding devices having lower resolutions. Three and three-eighths inches in diameter, it weighs only 5 lbs. 6 oz.

The transducer features a unique capacitive averaging technique. Accuracy depends on the precision with which the phase of two AC signals represents the relative angle between two stators. Since each signal is generated by the simultaneous action of 360 finely engraved serrations, with any inaccuracies averaged out over 360 samples, exceptional precision is assured.

First made for optical instruments such as the BALLISTIC RESEARCH LABORATORY'S Space Probe Optical Recording Telescope (SPORT), the BRL-5 has many potential uses. These include missile launching platform positioning, machine tool rotary table indexing, stable platforms, missile test range data acquisition, and air-borne instrumentation.

Produced in cooperation with Colorado Research Corporation, of Denver, the BRL-5 is another example of Norden's engineering excellence. Write, or call TRinity 4-6721, for complete data or engineering consultation.

NORDEN Division of United Aircraft Corporation

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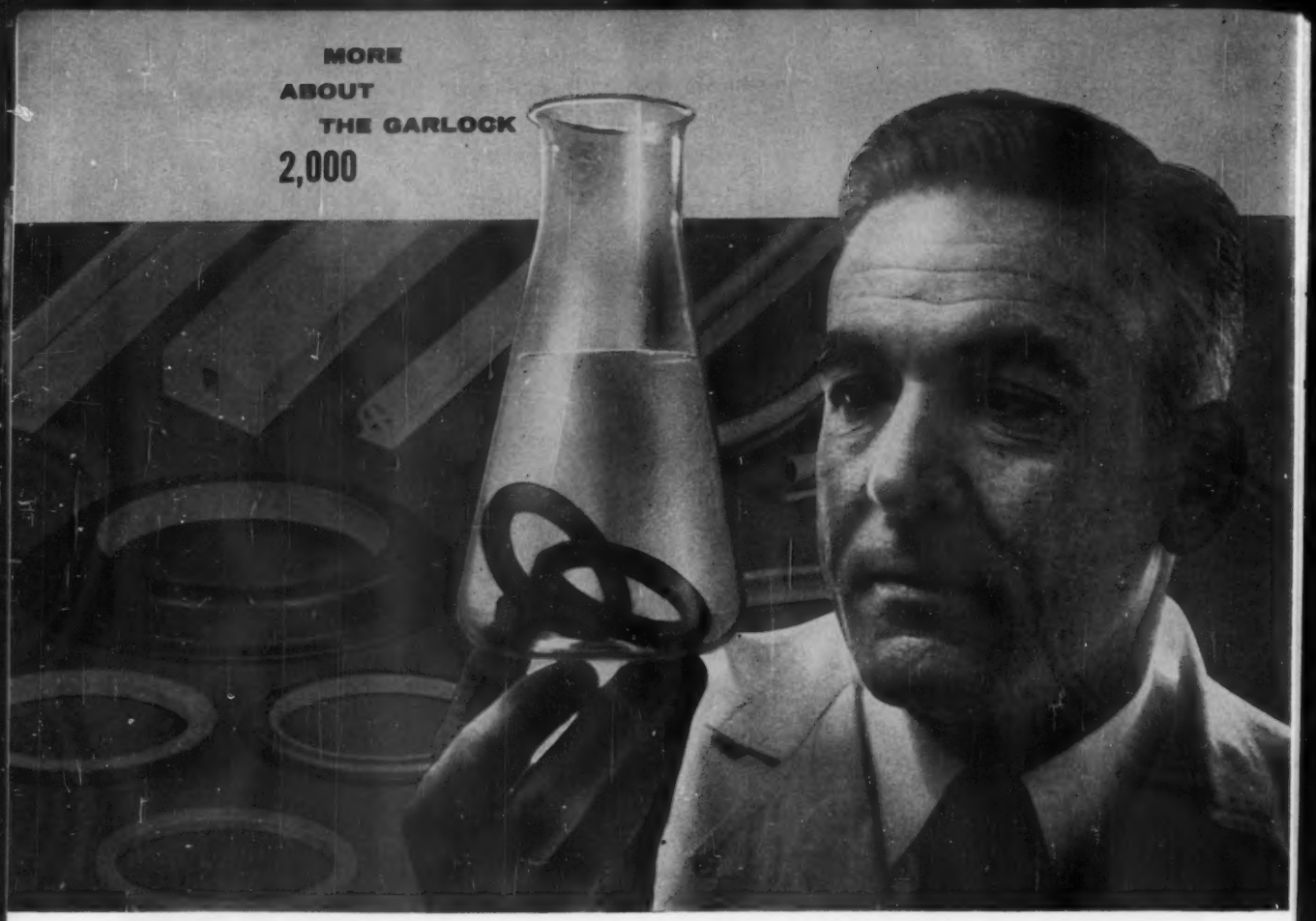

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Maria and the truck made ready that same day for continuing delivery. What otherwise might have been a two-day delay was reduced to less than one day.

Future plans to increase the aerial mobility of the Radford enterprises include the purchase of a single-engine, four-place airplane for the use of employes. Main idea is to permit engineers and other executives the same rapidity of contact possessed by Radford. Presently, Radford is the only member of his companies qualified to fly the Apache, although most of his executives have at least a private license. Since Radford feels a man is more valuable if he can fly, he plans to obtain an instructor's rating and combine business trips with his key men while giving instruction.

Visiting Planes Aid Tucson Commerce

Approximately $1,500 per day has been poured in the Tucson, Ariz., metropolitan area by pilots and passengers from some 205,000 transient aircraft stopping at this city's municipal airport, a recently completed 10 yr. survey indicates.

A program by the Tucson (Ariz.) Airport Authority during this period, ended April 30, 1959, entailed making survey cards available to someone aboard each visiting airplane. Sufficient data was obtained from 3.1% of the total number of civil transient aircraft to permit compilation of what the Authority believes is an accurate gage of the effect of business aviation upon a local community.

Of the 4,600 cards that were filled out by visitors, more than 2,600 indicated the extent of spending in the community. Of these 63.5% averaged $29.30 on aircraft service, 22% averaged $11.20 in transportation, 23% averaged $20.30 on lodging, 34% averaged $12.90 on meals, 11.7% averaged $18.08 on entertainment, 11% averaged $44 on merchandise and .76% averaged $75.62 on medical care.

By applying the dollar averages to the same relative percentages of the total number of aircraft visiting Tucson Municipal Airport, the Authority believes it is reasonable to assume that such planes were responsible for leaving $5.6 million in the metropolitan area.

More than $2.9 million was spent for aircraft services; $336,195 went for local transportation, $656,497 went for lodging; cafes and restaurants received $656,901, entertainment operators received $320,418 and merchants received $665,443.

The study also revealed that, on the basis of 4,231 survey cards, there was an average of 3.12 persons aboard the aircraft responding to the enquiry.

GROW WITH AIRESEARCH IN ELECTRONICS

• *AiResearch Central Air Data Computer for North American's A3J, Navy's first weapon system, provides information dealing with bombing, navigation, engine inlet control, radar, automatic flight control and cockpit instrumentation.*

Expansion in electronics and electromechanical activity is creating excellent openings at all levels for qualified engineers. Diversified programs include Central Air Data systems on the Air Force B-70 and F-108, North American A3J and McDonnell F-4H, as well as other commercial and military aircraft and missile projects.

Openings in the following areas:

- **FLIGHT SYSTEMS RESEARCH** General problems in motivation and navigation in air and space; required background in astronomy, physics, engineering.
- **DATA SYSTEMS RESEARCH** Experience with physical measuring devices using electromagnetic, atomic, thermionic and mechanical approaches.
- **CONTROLS ANALYSIS** Work in preliminary design stage involves servomechanisms analysis and analog computer techniques.
- **FLIGHT DATA COMPONENTS** Analysis proposal, design and development work in the following specialties: circuit analysis, servo theory, transducers, transistors, airborne instrument and analog development of high and low temperature problems.
- **ELECTROMAGNETIC DEVELOPMENT** Work with magnetic amplifiers requires knowledge of electromagnetic theory, materials and design methods.
- **INSTRUMENT DESIGN** Electromechanical design of force-balance instruments, pressure measuring devices, precision gear trains and servo-driven positioning devices. Experience in electrical and electromagnetic transducers desirable.
- **AIRBORNE INSTRUMENTATION ANALYSIS AND DESIGN** Work involves solving problems in accuracy, response and environmental effects.

Send resume to:
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CONVAIR'S supersonic F-106 Delta Dart, powered by a Pratt & Whitney J75 turbojet of 15,000 lb. thrust, plus afterburner, has a combat radius of about 500 naut. mi. Speed is in excess of Mach 2. Both armament and fuel are carried internally.

Aviation Week Pilot Report:

F-106 Hits Mach 2 on Radar Intercept

By Robert I. Stanfield

Andrews AFB—Air defense-capability of Convair's supersonic F-106 Delta Dart was evidenced by this AVIATION WEEK pilot-editor, flying a radar-guided intercept of a Martin B-57 "invader" up to 48,000 ft. at speeds inclusive of Mach 2, straight-and-level.

The all-weather jet interceptor, coupled with its Hughes MA-1 aircraft and weapon control system, and acting on information programed from SAGE (semi-automatic ground environment) and TACAN (tactical air navigation) stations, can be flown automatically from wheels-up following takeoff to flare-out before touchdown.

Complete F-106/MA-1 weapon system is designed to intercept and destroy enemy bombers, both subsonic and supersonic, operating from sea level to over 70,000 ft. Armament includes the Hughes Super Falcon GAR-3 radar-guided and GAR-4 infrared-guided missiles and the Douglas Genie MB-1 atomic rocket. Both armament (in the belly) and fuel are carried internally, though the Dart can be equipped with droppable wing tanks for ferry flights.

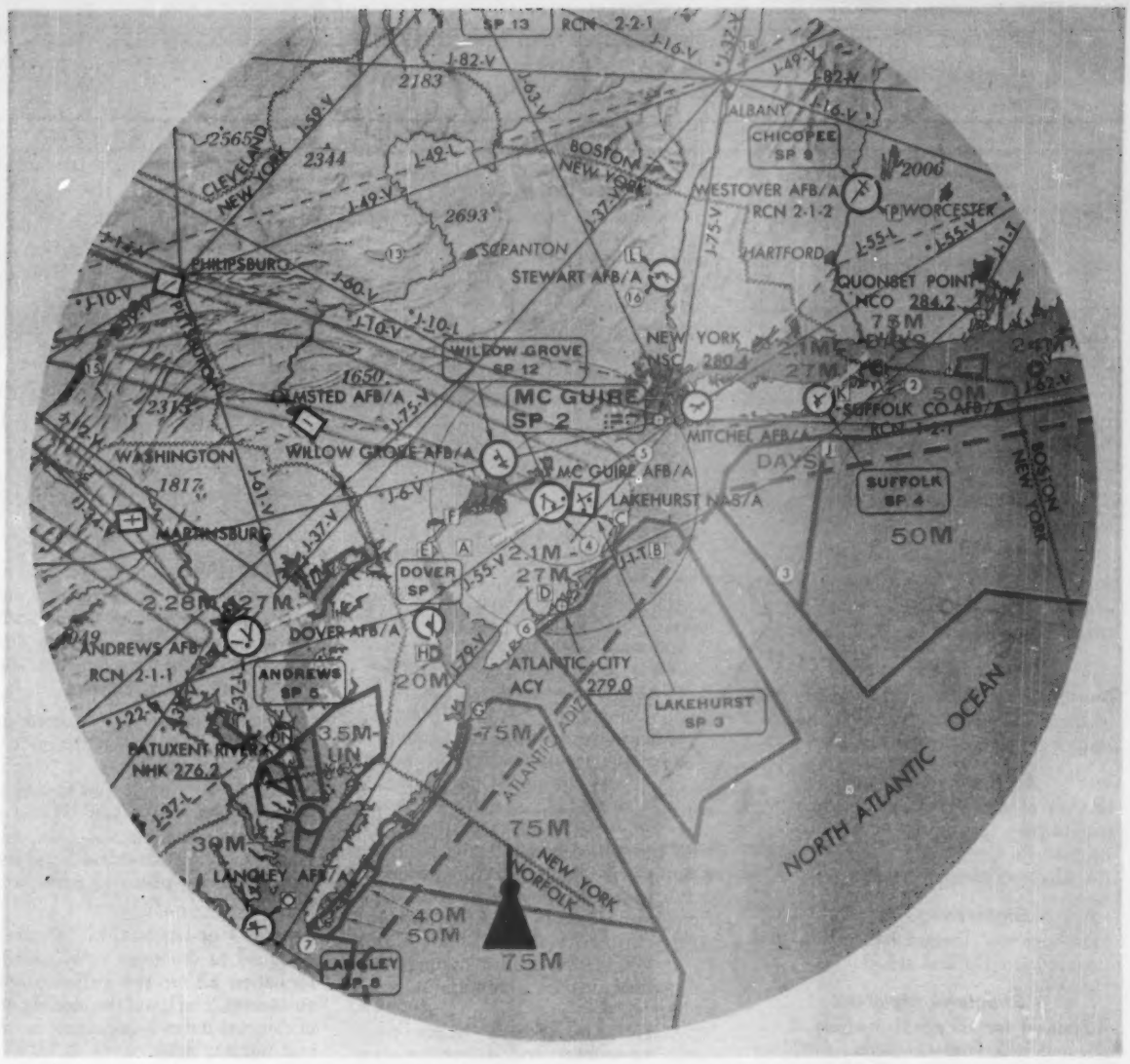
Power is supplied by a Pratt & Whitney J75 turbojet of 15,000 lb. thrust, plus afterburner. Ferry range of the F-106 is 2,350 naut. mi. Combat radius on internal fuel is about 500 naut. mi. Wing span is 38 ft., 1.6 in. Length is 70 ft., 8.78 in. Height from ground to top of vertical fin is 20 ft., 3.52 in.

ARMAMENT for the F-106 includes the Douglas Genie MB-1 atomic rocket and the four Hughes Super Falcon GAR-3 radar-guided missiles, shown with the all-weather interceptor.

Digital Computer

"Brain" of the MA-1 is the "Digitaire," the Dart's airborne digital computer. Key subsystem is the Tactical Situation Display (TSD) that projects a map display on a cockpit screen permitting the pilot to follow the course of the mission pictorially. Maps change automatically, according to the aircraft's location. Small symbols on screen represent the interceptor, the target's position and movement, and the heading the F-106 should fly to reach the target.

Aircraft's automatic flight control system (AFCS) operates its elevons (movable aileron-elevator surfaces on rear of wing) in response to commands received from the digital computer. Information received by the AFCS originates in the flight-sensing instruments,



TACTICAL Situation Display map allows the pilot to follow the course of his mission pictorially. Note small black symbol, bottom-center, representing the interceptor as seen by pilot. Maps also show the position and movement of the target aircraft.

ground stations feeding intelligence to the MA-1, the airplane's own radar system and the computer's own memory drum. AFCS also functions during the return portion of the mission.

Once within combat radius the Dart's own airborne radar system guides the airplane to where it automatically launches its armament, following which it may be automatically flown back to its own base.

The F-106A is now operational with the North American Air Defense Command (NORAD). Its first flight was in December, 1956. It was first operational last June with Air Defense Command's 539th Fighter Interceptor Squadron at McGuire AFB, N. J. (AW July 27, p. 41), where it is undergoing Category 3 (environmental) testing. Darts are also moving into the 95th FIS at Andrews AFB, Md., and

SAGE Direction Center at McGuire AFB, N. J., headquarters of the N. Y. Air Defense Sector. Windowless building, four-stories high, is built of self-blasting concrete.

NEW VOUGHT PROJECTS OFFER CAREER APPEAL TO CREATIVE MEN

Space, ASW, and weapon system work at Vought requires continuous R & D in methods and materials, structures and design. These projects have prompted exploratory work in the following areas:

Structures (Supersonic and Hypersonic)
Heat transfer, thermal stress and deflection analysis, and stress analysis using high-speed computers.

Manufacturing R & D
Welding and brazing of super alloys and exotics; advanced forming and cutting studies; prediction of metal fabricability.

Industrial Engineering
Project estimating, work sampling, line load and balance, and packaging and installation of new procedures.

Antisubmarine Warfare
Studies of detection and classification techniques involving Acoustics, Geomagnetism, Geophysics, Electromagnetics, Electrochemistry, Math.

Engineering Planning
Man-hour and budget forecasting, and project planning and scheduling.

Structures Materials
Advanced metallurgical analysis of exotic materials. High-temperature studies. Refractories, ceramics. Fusion welding of precipitating hardening stainless steels and tool steels.

Flight Test Instrumentation
R & D in new techniques for electronic gathering and reducing of flight test data.

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to Geiger AFB, Wash., and Castle AFB, Calif.

Performance and characteristics of this weapon system, some of which were noted during AVIATION WEEK intercept, included:

• **Navigation methods.** Available are: standard close control in which aircraft operates under direct guidance of a ground radar station; modified close control in which the F-106 does its own vectoring based on target data (altitude, speed and direction) from SAGE and TACAN; AUTONAV, which uses only TACAN data and requires no information from SAGE. Any of these systems may be flown either manually or automatically.

• **Attack course.** This can be either lead collision or pursuit, depending on the attack situation, and has special steering for visual identification in peacetime. Any attack can be flown either manually or automatically.

• **Counter-countermeasures.** Varied tracking, homing features are incorporated into F-106 weapon system.

• **Speed-altitude envelope.** Maximum speed is specified in excess of Mach 2. Maximum steady-state altitude is about 57,000 ft. with zoom capability higher. With proper use of the F-106/MA-1 system, targets up to 70,000 ft. can be attacked successfully via snap-up (a zoom attack from beneath the target, based on computation of target altitude and F-106 altitude and speed. Angle of zoom varies with each attack and with type of weapon to be fired).

• **Range-test flights.** Ferry mission of 2,350 naut. mi. allows a nonstop flight from Edwards AFB, Calif., to McGuire AFB. Altitude would be about 41,000 ft. at Mach .92. Test or training mission would assume a two-minute dash at Mach 1.6.

• **SAGE tie-in.** Search radars cover both interceptor and target, sending data to the SAGE center by telephone lines. All commands to the F-106 may be sent either by voice or automatic digital data link. Control of the air battle is with the SAGE direction center. The F-106 would be used simultaneously with other interceptors, such as Bomarc and Nike missiles.

• **Armament.** MB-1 can be used at all aspect angles at targets that are not jamming or otherwise destroying accurate launch range information. GAR-3A and GAR-4A have a variety of counter-countermeasure features and do not require precise range information for such successful launch.

Intercept of a Martin B-57 twin-jet "invader," flying at Mach .6, was made from Andrews AFB and coordinated with the New York Air Defense Sector's SAGE direction center at McGuire AFB. Airplane flown was F-106B 57-2522, two-place tandem version with trainer capability. The "B" has all the

VOUGHT TAKES AIM AT THE SUBMARINE

Submariners, submarines and sub-launched missiles are intimate friends of a special engineer/scientist task force at Chance Vought.

Vought's ASW team, drawing on a ten-year backlog of comprehensive submarine experience, is working with the Navy and its Fleet units to develop advanced means of protection against attack from under the seas.

Vought engineers have assisted in the design of the missile installation in some of the Navy's newest subs. They have cruised aboard missile subs in pioneering voyages. They have learned the ways and habits of submarines. The company now is applying this valuable insight into virtually every phase of antisubmarine warfare.

Vought's oceanographic studies are designed to discover new, usable information about the submarine's environment. The lay of the land thousands of fathoms down is important in finding and fighting subs.

Fleet subs and aircraft are being operated for Vought in other tests. Under contract with the Office of Naval Research, company scientists and engineers are investigating sub detection techniques which employ new phenomena.

Vought's weapons-wise design and manufacturing teams can be counted on to transform the newest findings into complete and effective defensive systems, in *whatever direction* ASW studies lead.

Antisubmarine warfare, along with atmospheric missile and piloted aircraft development, are specialties in Vought's Aeronautics Division. Other major interests are being aggressively advanced in the company's Astronautics, Electronics, Research, and Range Systems Divisions.

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DALLAS, TEXAS

SALT WATER SHELL GAME

Find the sub. It is somewhere in the ocean basins that cover 70 per cent of the earth's surface. Listen for its motors. Find the hum that is lost in the din of marine life. Keep the sub at a safe distance. With one of its nuclear missiles, it can destroy any U. S. city. Don't be decoyed by a single prowler . . . an estimated 450 more subs need watching, too. So go the steps in one of history's toughest defense problems. So runs the routine aboard Navy ships and planes. Round-the-clock work reinforced by the efforts of American industry and ingenuity to provide the equipment needed to cut the Free World's biggest menace down to size.

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AVIATION WEEK Pilot-Editor Robert I. Stanfield prepares to take off in Convair F-106.

performance characteristics of the single-place "A" but incorporates the additional seat, compensated for by a smaller fuel capacity.

Along with AVIATION WEEK pilot, and in the front seat, was Maj. Joseph W. Rogers of Air Defense Command headquarters.

Built by the Convair Division of General Dynamics Corp. in San Diego, Calif., the F-106 is not unlike its Convair predecessor, the F-102A, in appearance. Both are delta-wing aircraft with identical spans. The Dart incorporates a dual nose gear and truncated vertical fin. Its air inlet ducts are moved back of the cockpit to the wing root, accentuating the wasp waist of its fuselage. Small notch cut into wing leading edge prevents excessive spanwise flow, (aiding low-speed landing characteristics), replacing the aerodynamic fences used on the F-102A.

The F-106 sits high, and a ladder is used for climb to the snug cockpit. The pilot is tightly rigged with Mae West life jacket, chute, and emergency equipment. Oxygen is fed under pressure via a mask worn throughout the flight, from initial taxiing to final touchdown. The microphone is "hot," and the mike button need only be activated for outside transmission.

Instrument panel is small and compact. Left side included a drag chute handle, command and target altitude indicator (which would show altitude of target and prescribed altitude for snap-up to target), needle and ball, acceleration indicator, Mach indicator (to 2.2) and airspeed indicator, (to 820 kt.) altimeter and clock.

Center panel includes data link annunciator (which shows whether the F-106 computer is taking data link signals), computer TACAN annunciator (which tells if TACAN is furnishing navigation information to computer or if the computer is dead-reckoning on its own stored information), ILS coupling equipment, directional gyro (which doubles as TACAN, ILS instrument), altimeter and rate of climb. Right side of main panel seats gages for pressure altitude, pressure ratio (measuring efficiency of compressor), exhaust temperature, tachometer, fuel flow, fuel quantity, and warning lights.

Geographical Map Displays

The Tactical Situation Display screen is centered below the main panel. Geographical map displays are screened through a 35 mm. film strip, illuminated from behind. Side panels include radio-navigation controls. Ejection levers, at seat sides, require but one 60-lb. pull for both canopy and seat.

Engine was fired up in the alert hangar and the Dart was taxied to takeoff position on Andrews' north runway. Sea level pressure was 30.14 in. Wind was only 3 kt., from the northwest. Outside air temperature was 28C. Low-level haze, which held throughout the flight, reduced forward visibility to 2 mi.

Gross weight on takeoff, with 9,000 lb. of fuel in the F-106B and two aboard, was about 35,000 lb. Empty weight of this airplane is 26,000 lb. Specifications call for an F-106 ground run, depending on weight, of no more than 2,700 ft. (to 4,300 ft. over a 50 ft. obstacle). Landing ground roll, depending on weight, should run no more than 3,200 ft. (to 7,200 ft. over a 50 ft. obstacle).

With instruments indicating normal, power lever forward, the Dart started down the runway at 1205 EDST, really kicking out when the afterburner was brought in after about 15 ft. of roll. The F-106 was airborne 22 sec. later, after a run of about 2,500 ft., breaking ground at 175 kt.

Military climbout was initiated and the airplane passed through 7,000 ft. indicating 440 kt. (Mach .75), rate of climb controlled to 3,500 fpm., far below true capability. Afterburner, of course, was cut out at 3,000 ft. Looking aft, we could just see the end of each wingtip.

Airplane had moved into the scramble corridor, on the 60 deg. radial of Andrews' TVOR. Our TSD worked beautifully, and we could see our progress over the terrain below. The F-106 had gone to its own autopilot (which will hold aircraft to its exact position when engaged) immediately after takeoff and at 11,500 ft., still climbing at 3,500 fpm. (420 kt. indicated), SAGE took control of the aircraft from Andrews RAPCON. At this point valid data link signals were being received, and airplane was about 20 mi. west of Dover AFB, Del.

The Dart was automatically climbed through 20,000 ft., still indicating 420 kt. and 3,500 fpm. rate of climb, and up to 37,000 ft. At 37,500 ft. our cabin altitude was 15,000 ft. Speed was Mach 1. The B-57, which had begun its run from Montauk Point, Long Island, at Mach .6, was indicated to be at an altitude of 41,000 ft.

Interceptor was headed out to sea by SAGE over McGuire AFB, crossing the coast on a heading of 105 deg. SAGE steering was somewhat erratic, and large corrections were being pumped into the F-106. The Dart was closing in fast on the B-57, and far in the distance, 6,500 ft. higher than the interceptor, the first contrail of the B-57 could be seen.

The B-57 was now indicated at 43,000 ft. Our offset turn was made at 36,600 ft. and airplane steadied in on a course of 180 deg. Speed was still Mach 1 when afterburner was brought in and, with target contrails and B-57 plainly visible, the Dart was "snapped up" at Mach 1.3. The B-57 was now locked into the F-106's own radar system, and was a sitting duck. By the time the F-106 had zoomed by (we got one hasty look) and turned around, some 20 mi. had been covered and the B-57 was out of sight.

The F-106 is capable of snap-up from more than 10,000 ft. below its target. Coming up from below affords a good radar blip, and is also the initiation of a good escape maneuver when using an atomic weapon.

During the entire phase of this operation, the F-106 was flown automatically, through SAGE and its own sys-

tem, except for those moments when this AVIATION WEEK pilot took over the controls for manual flight, and when the airplane was taken off and landed. It is not an oversensitive airplane; control response is good and feeling of stability is apparent.

As Brig. Gen. Arthur C. Agan, Jr., commander, New York Air Defense Sector, told AVIATION WEEK: "The F-106 is the final step in evolution . . . with the capability of a guided missile . . . the weapon can be controlled as a guided missile, but has alternative schemes to give a fighting man the chance to think and observe."

A snap-down to target (attack from above, controlled by computer so as not to exceed 1.5 negative g in the F-106) is not a recommended procedure, though Gen. Agan, who feels he "will fly a tactical airplane once a week or quit," and who keeps in touch with the entire system by flying regularly, has snapped down on targets, during night missions, from altitudes up to 12,000 ft. higher than the "enemy."

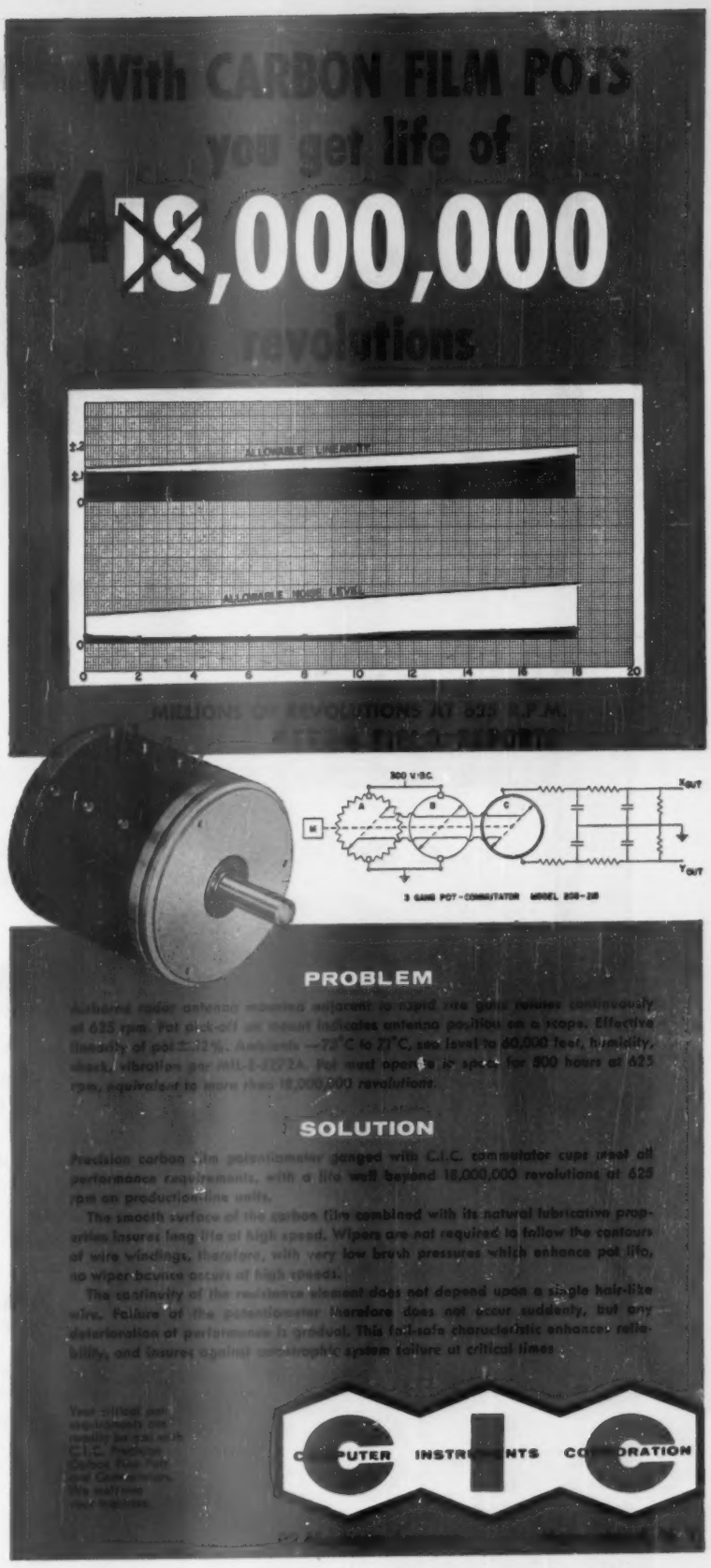
Mach 2 Flight

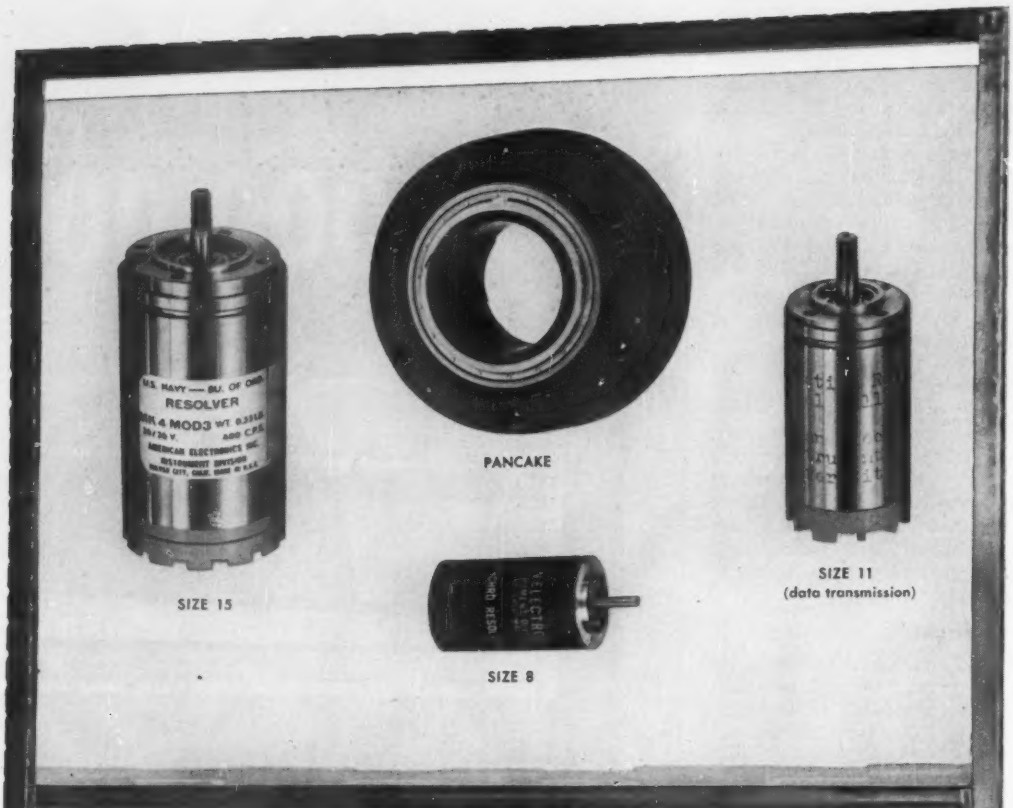
F-106 had climbed to 48,000 ft. following the target run, and indicating Mach 1.5 had descended to 43,000 ft. at the rate of 6,000 fpm. At this altitude, flying straight-and-level, speed run was initiated in which the airplane covered about 150 mi. in a hurry. The airspeed needle ran through Mach 2, the only abnormality being the sudden lighting of the maneuver warning light, which came on at maximum maneuver speed of Mach 1.9.

After again taking the controls manually, the airplane was headed to Patuxent River where initial descent to Andrews AFB would be made from 20,000 ft. Descent to this altitude, throttle back and speed brake out, was made at 6,000 fpm. at an indicated speed of 350 kt. Should Andrews have included operative ILS, a coupled, automatic approach could have been made to flareout.

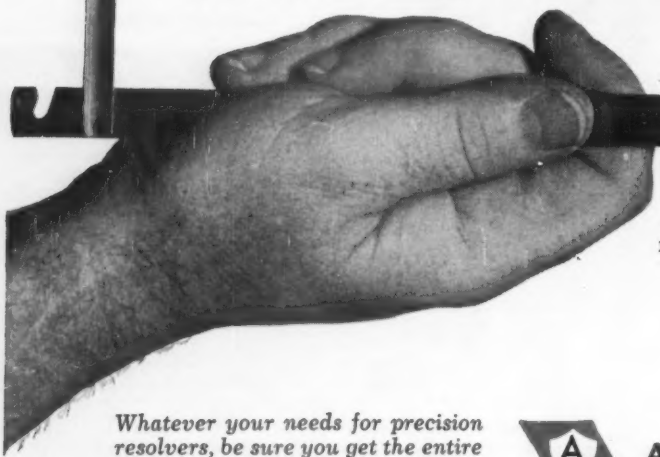
Dart was brought in via GCA (ground controlled approach), descending to 1,500 ft. The fuel warning light burned as level reached 1,200 lb. The airplane was flown through 4,000 ft. at 280 kt. indicated, descending, and gear was lowered at 220 kt. indicated. Approach was slowed to 190 kt. and the F-106 descended through 1,500 ft. at 2,500 fpm. Touchdown was made at 150 kt. (about 173 mph.), one hour after takeoff, drag chute being popped just before touchdown.

The importance of the F-106 as an all-weather, fully automatic air defense weapon cannot be underestimated. Except for those moments when the airplane was deliberately flown manually, control was fully automatic, via both data link and a voice cross-check made





THE COMPLETE RESOLVER PICTURE



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IR11N4-159, SIZE 11	400	57	11.8	356 + j1950	17	0.1	1.902 ± .038		4.7	−55° TO +125°
IR15W4-425C, Mk 4 Mod 3, SIZE 15	400	60	15	240 + j1000	15	0.1	.980 ± .020	1.000 ± .00025***	8	−55° TO +85°
25J90-44A, PANCAKE	1600	4	4	3600 + j5200	4	0.1	.975 ± .020	1.000 ± .002	6	−55° TO +85°
IR23W4-755*, Size 23	400	100	20	775 + j5650	16	0.03	.975 ± .020	.985 ± .010	28	−55° TO +85°

*Not illustrated. **Non/comp available with input impedances of 467 + j1580 Ohms and 130 + j370 Ohms. ***When trimmed with BuOrd Amplifier.

with SAGE controller. What limitations there are stem from basic radar; the worst of these would be height finding. The aircraft has two electrical systems, each of which has an alternate.

In event of failure of radar vectoring, new TSD maps will also include prescribed scramble and recovery tracks, Lt. Col. James R. Cook, chief of operations and training, N. Y. Air Defense Sector, told AVIATION WEEK. TACAN and VOR patterns will overlay on current maps.

Data from the radar network that is fed into SAGE centers includes information received from Navy picket ships, airborne early warning aircraft, Texas towers, DEW Line, Mid-Canada Radar Line, Pinetree Line, Navy blimps, etc.

Data is transferred to IBM punch cards, then inserted into the computer's brain. The computer evaluates the information and stores it in "memory cores," or tapes, which may be used again. Time required to store or recall information is measured in microseconds. Over 4 million bits of information may be stored for instant release.

SAGE Center

The center itself is housed in a windowless four-story building built of blast-resistant reinforced concrete. The outside walls are six-feet thick and the interior partitioning walls are 12 in. thick. Air conditioning holds the temperature to 72 deg. inside. An alternate system is on tap, for should the power fail the heat generated by the electronic equipment within would in three minutes run the temperature in the neighborhood of 130 deg.

The SAGE organizational setup incorporates seven divisions, under direction of NORAD at Colorado Springs, Colo. Each division is made up of up to five sectors, similar to New York's, for which 26th Division headquarters is at Hancock Field, Syracuse, N. Y.

The Weapons Room at the New York Sector embraces four teams, with five intercept controllers under each team director. Each controller can handle one to 10 intercepts simultaneously, depending on his proficiency, with data link cross-checks being made by voice. During intercept the computer makes a new calculation every 15 sec. The SAGE digital computer, the AN/FSQ-7, can make up to 65,000 computations per second.

Units of the N. Y. Air Defense Sector include, in addition to the 539th and 95th FIS's at McGuire and Andrews, the 46th Air Defense Missile Squadron (Bomarc), the 5th FIS at Suffolk County, N. Y., AFB, the 6th Air Defense Missile Squadron (Bomarc), and the 646th, 770th and 773rd radar squadrons at Highlands and Palermo, N. J. and Montauk, N. Y., respectively.

Navy Improves ASW Acoustic Devices

San Diego—Solution to the anti-submarine warfare problem may lie in better understanding of the ocean's characteristics, rather than in the development of a new technique or device, according to Dr. J. Warren Horton, technical director of the Navy's Underwater Sound Laboratory at New London, Conn.

Research and development, aimed at improving ASW capability, is a $219 million program in the Navy and was the subject of a symposium here sponsored by the Institute of the Aeronautical Sciences.

Adm. H. G. Hopwood, commander-in-chief, U. S. Pacific Fleet, said that the Navy is not counting on a so-called "breakthrough" in technology but is concentrating on improving present magnetic and acoustic devices for submarine detection. Key to solving the detection problem may lie in charting the oceans and learning more about temperature layers, currents and the nature of the ocean floor and how these characteristics affect accoustic wave propagation, he said.

Only about 2% of the seas are accurately charted and from increased

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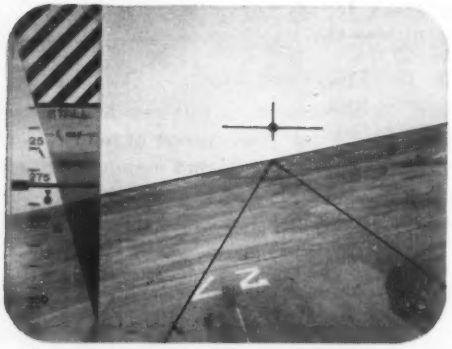

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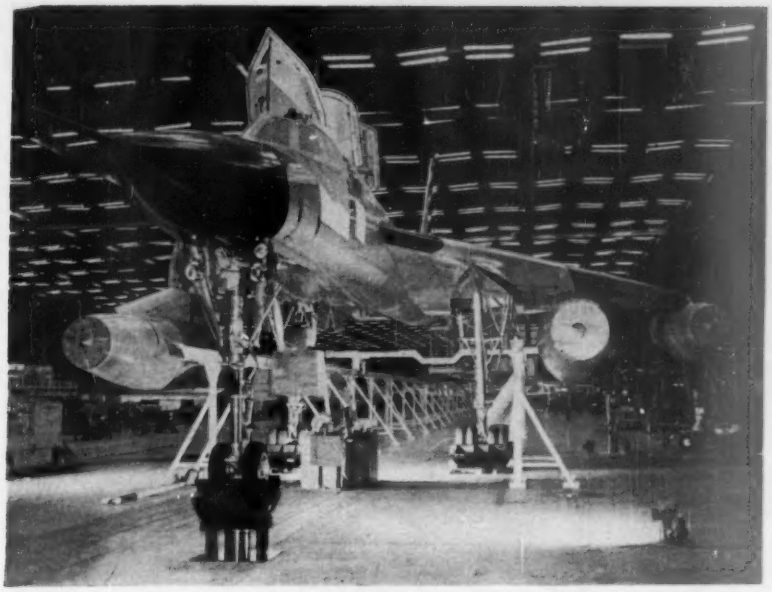

Completed B-58 Lowered From Assembly Line

Convair B-58 Hustler jet bomber is hydraulically lowered at end of elevated assembly line at Convair Division of General Dynamics Corp.'s Ft. Worth, Tex., plant. Assembly line is 9 ft. above floor level. USAF has cut its Fiscal 1960 procurement program for the B-58 from 40 to 32 aircraft (AW Aug. 17, p. 26)

oceanographic research may come a better understanding of underwater phenomena, which in turn may lend itself to solving the submarine detection problem, according to the admiral.

Earlier, Adm. J. S. Russell, Vice Chief of Naval Operations, told the symposium that Russia has a fleet of 450 submarines and the Navy needs a device which can search the ocean depths to the same extent that radar can the sky.

Impression gathered from both the military and civilian scientists attending the symposium was that the detection and identification of a submarine in 78 million sq. mi. of ocean is one of the most challenging tasks ever posed to technical minds, but there was no announcement of anything new in the way of detection methods.

Naval Electronics Laboratory is concentrating its efforts on improving sonar which has seen an increase in range of at least one order of magnitude since the end of World War II. Biggest problem area in sonar is discriminating between returns from submarines and the returns from marine life and other ocean phenomena.

As to hardware problems, an official said that transducers, used to impart sound energy into the water, are the biggest single source of worry.

Anti-submarine warfare has grown to such proportions now that the Navy is devoting over half of its effort to it and has resulted in two major changes being made in the Pacific fleet, Hopwood announced.

First, Vice Adm. M. E. Curts, commander, Western Sea Frontier, has been given the additional title of commander, Naval Defense Forces, Eastern Pacific.

He will have operational control of fleet units to defend the West Coast against enemy submarine attack. Hopwood said that the Eastern Pacific area extends from Hawaii eastward and from Alaskan waters to South America.

Second major change is the establishment of a deputy commander-in-chief, U.S. Pacific Fleet, for anti-submarine warfare. Carrying with it the rank of vice admiral, the new deputy will have the responsibility for evaluating new equipment, developing new ASW tactics, and supervising training.

Hopwood also said that the Navy is in good shape to kill an enemy sub once it can be located but "we are really up a tree, not of our own choosing, when it comes to the ASW problem."

"We must assume that in the not too distant future the Communists will have atomic-powered submarines designed to launch missiles. Some of their conventional submarines may be able to launch missiles already," Hopwood added.

In addition to the $219 million research and development program on ASW presently under way, the Navy has asked for an additional $100 million, according to Vice Adm. H. A. Yeager, ASW executive in the office of the Chief of Naval Operations.

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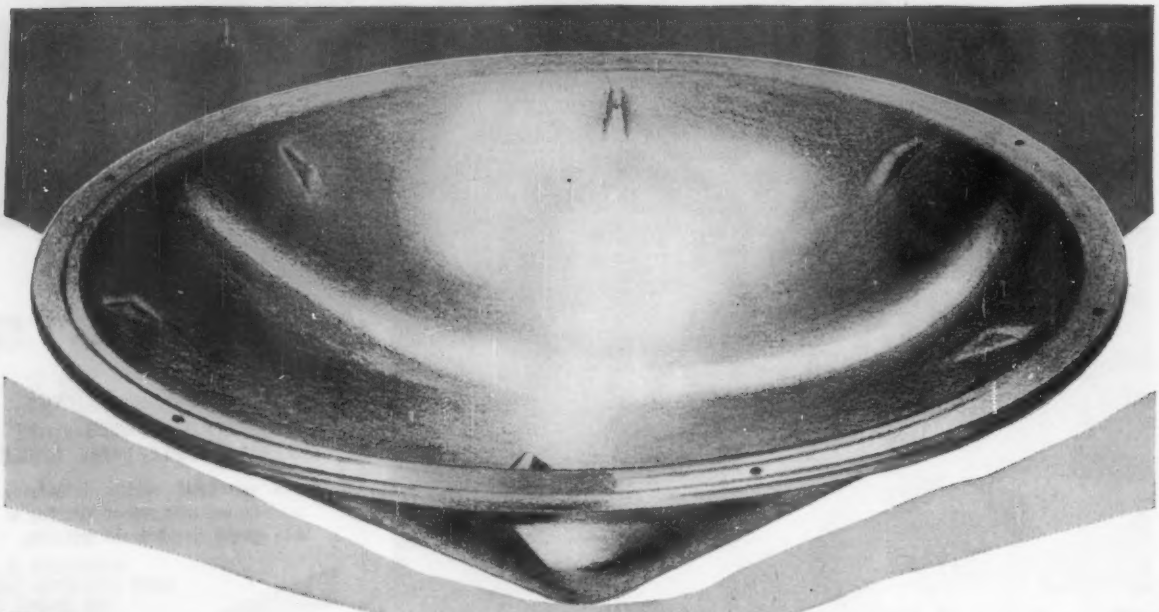

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AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Red Bank Division, Bendix Aviation Corp., Eatontown, N. J., 371 ea., generators, engine driven, aircraft 30 v., d.c.-200 amp, Aerno 42-1910, for H-34A, IFB 33-600-59-223(MIPR R59-4248-TCSMC-E), $170,693.

Kollsman Instrument Corp., Elmhurst, N. Y., maintenance data (for all Aerno components of the type MD-1 automatic astro compass), (PR EG-9-05A-4439), $33,-757.

The Houston Fearless Corp., Los Angeles, Calif., replacement parts for A-9 and A-11 processing machines (ground support equipment), (PR's MO-9-6740-1725, MO-9-6740-1733 and amendment No. 1 and MO-9-6740-1738 and amendment No. 1), $29,911.

Motorola, Inc., Chicago, Ill., system responsibility for AN/APS-64, reports and field engineering services, (PR-EG-9-16K2-4460), $94,730.

Fairchild Camera and Instrument Corp., Syosset, L. I., N. Y., 71 ea., 1¼" lens bodies CAX-12, 70 mm. camera system, 386 ea., cases, carrying and storage, end use: Navy F8U aircraft, (MIPR R59-3293-68-NOas), $454,923.

Crosley Division, Avco Manufacturing Corp., Cincinnati, Ohio, 114 ea., cable assembly boosters; 30 ea., pressure regulators; six ea., drive assembly azimuth; 20 ea., unit true air speed and density transmitter, end use; applicable to the MD-9 fire control system, B-52 aircraft, (PR's WR-9-1270-1011 and WR-9-1270-1014), $36,217.

Beech Aircraft Corp., Wichita, Kans., RL-23D aircraft, spares and ground support equipment, (MIPR R59-912-TC), $145,000.

Boeing Airplane Co., Wichita, Kan., replacement facilities for production of B-52 aircraft, (PR BI-9-F-9172), $350,000.

The Reflectone Corp., Stamford, Conn., one ea., training set, countermeasures, reconnaissance, AN/ALQ-T3; five ea., training sets, countermeasures, jamming, AN/ALQ-T4, (PR's PE-9-28-4068, PE-9-28-4069 and CE-9-6910-4661), $1,813,152.

Electronics Division, Curtiss-Wright Corp., Carlstadt, N. J., eight ea., propeller assemblies, model C634S-C104 with three design 1060-1C4-12 blades including electrical de-icing and electrical de-icing blade boot sheaths; 22 ea., power unit assemblies, P/N 158512; two ea., motor and contractor assemblies, P/N 158570 for: APG-3W airship, MIPR R57-172-NOas and amendment No. 1, $301,598; 35 mm. camera, motion picture instrumentation, type KG-10, 70 mm. camera, motion picture instrumentation, type KG-9 and data, use: for service test (aircraft—unknown), PR PE-8-10A-3646), $301,115.

Giannini Controls Corp., Pasadena, Calif., five ea., accelerometers, linear, aircraft remote and indicators, data and engineering services for: service test. (PR EA-ST-4603), $65,326.

Air Products, Inc., Allentown, Pa., 1,000 lb. of tetrabourohhydrazine (for testing), (PR EM-9-RD-6404), $96,000.

Graflex, Inc., Rochester, N. Y., 55 ea., camera sets, KS-6(1), still picture, S/N 6780-298-9681; 55 ea., stroboflash lamp head adapters. Graflex catalog No. 7042 (ground support equipment), (MIPR R59-30312-150-USMC-03), $111,699.

Convair Division, General Dynamics, Ft. Worth, Tex., 1 ea., B-58 mobile training unit (consisting of several trainers and test equipment thereof), (PR SB-9-6900-7316), $2,712,132.

Chemical & Metallurgical Division, Silicone Products Department, General Electric Co., Waterford, N. Y., experimental lubrican (one pint and 10 gal.), for evaluation tests in advance powerplant and hydraulic systems, (PR EM-9-RD-6221), $73,174.

Aerial Machine & Tool Corp., Long Island City, N. Y., 8,919 ea., belts, aircraft, safety, lap, troop, type MC-1A, Aerno 452429 for use on C-130B and KC-132 aircraft, IFB 33-600-59-163 (PR EA-9-03F-4541), $39,-243.

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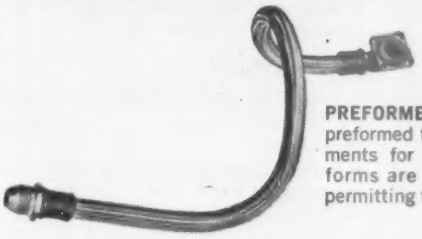

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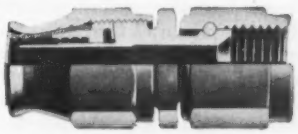

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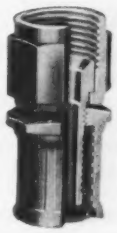

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USAF Accidents May Hit All-Time Low

By William S. Reed

Norton AFB, Calif.—Indications are that U. S. Air Force's flying safety campaign will reduce the accident rate for 1959 even below the record low rate of 10.4 accidents per 100,000 hr. flying time chalked up for 1958. The 1958 achievement contrasts sharply with the all-time-high accident rate of 506 per 100,000 hr. for Army Signal Corps in 1921.

Queried by AVIATION WEEK what one single program would be most effective in continued reduction of the accident rate, Maj. Gen. Joseph D. Caldara said, "education." He included not only flight crews but all personnel in any phase of aviation. Caldara was former Director of Flight Safety Research for USAF Headquarters and now is Deputy Inspector General for Safety. Brig. Gen. Walter E. Arnold now heads the Directorate of Flight and Missile Safety Research.

Just how much farther an educational program can go before the saturation point is reached is a difficult question to answer. Many pilots on the receiving end of Flight Safety's campaign think the subject already is saturated. Too much emphasis on the annual award of flight safety plaques and the attendant honor bestowed on a commander whose unit receives it, places pilots under a great deal of strain. Sometimes Air Force prestige suffers, as in the recent Paris air show where flying displays by British and French teams took the spotlight (AW June 29, p. 20).

Human Aspect

Accident-free flying is virtually unattainable because of one fact—aircraft, regardless of size or nature, are designed, built, maintained and operated by people. It is toward the human aspect of aviation that DFMSR directs its greatest effort.

Science was first applied to aircraft accident prevention in 1950. Victor E. Bertrandias, who retired as a major general in 1955, was appointed to the Direcorate of Flying Safety, then located at Langley AFB, Va. Later that same year, operations shifted to the present location here.

Ensuing nine years has seen flying safety emphasis shifted from a largely historical and statistical function to one of reasearch and active accident prevention. Although much remains to be done in many respects to make flying safer from the mechanical standpoint, emphasis on human factors contains the broadest area for study.

Not only flight crew problems are under study, but all personnel who contribute in any way to aircraft flight come in for scrutiny.

Safety Efforts

Aeromedical Safety Division directs its accident prevention efforts along these lines:

- **Aeromedical research** and studies to keep abreast of the latest developments with an eye toward incorporating these ideas in present day and future aircraft and their environments.
- **Human injury** and psychological analysis studies to minimize accident injuries and at the same time determine why accidents occur. Protecting ground personnel and air crews from injury as well as accident-inducing situations is the prime concern.
- **Aeromedical statistical research** maintains records on such items as pilot age, distribution and the morbidity statistics (fatality and injury data).

Three branches comprise the Aeromedical Safety Division: Human Factors, Injury and Survival, and Physiology and Toxicology. Each of these branches are primarily concerned with spotting trends with an eye to reducing accidents.

Dr. A. F. Zeller, psychologist with the Human Factors Branch told AVIATION WEEK that the biggest single factor in aircraft accidents today is vertgo. It can take on many different forms but in the final analysis, momentary or complete loss of orientation is the biggest accident cause. Human involvement figures in two-thirds of all accidents; pilot error is the primary cause in one-half of the accidents. However, the onus is not strictly on the pilot, as far as Dr. Zeller is concerned. He said that most times, the pilot is "backed into a corner" by a series of events wherein he cannot make the right choice.

BRIG. GEN. WALTER E. ARNOLD

Errors are sometimes made because it is beyond human capability to do the right thing. The more or less grim joke about every accident being pilot error because the pilot got into the aircraft is recognized here, although in executing a last final move the pilot may have had no right choice. Often an initial wrong choice is compounded by trivial errors and can be listed as the primary cause of an accident.

Habit Patterns

Statistics show, Dr. Zeller said, that older pilots are less able to transition into jets than are younger, less experienced pilots, due mainly to habit patterns formed during long years of flying conventionally-powered aircraft.

Psychologically speaking, experience tends to produce habit patterns to which an individual under pressure may revert.

Compression of Time

Compression of time due to increased speed is explained by Zeller as the cause of the high accident rate in transition from props to jets. In the man-machine relationship, he said, it is man who is limited by design. However, newer, high performance aircraft exact a greater performance requirement from man which he can only cope with through training and experience. The entire information-decision-action sequence may be rendered ineffective because of exceeding various types of physiological tolerances. This explains, in part, the high incidence of accidents which occur during the landing phase. He said that the physical limitations of man's sensory systems do not enhance his ability to judge rate as well as vertical distances. When it is necessary to integrate both of these judgments in a very limited time, the probability of error is quite high.

It may be the results of human factors studies which caused Bertrandias to make some dire predictions. He is still active as a director of the Flight Safety Research Foundation.

He criticized the short transition course given by airlines, saying that airline pilots have had as little as six hours in a jet aircraft before acting as captain on a run.

One method whereby pilot performance may be enhanced, according to Zeller, is by improving display information. From a human factors standpoint, he favors the Army-Navy instrument panel over the WADC integrated flight instrument panel (AW July 6, p. 54), because he says the latter is not truly integrated. He maintains it is not as realistic a manner of displaying performance and position as in ANIP. He says that it is an improvement over present panels, however.

He stresses standardization as important in panels and cockpits but to the point that it inhibits progress. Improvement in standardized panels must be in blocks rather than by bits and pieces.

Night Lighting

Dr. Zeller also pointed out that a reversal is in progress concerning cockpit night lighting. Dark adaptation by red lighting was thought extremely important and was used exclusively in late model aircraft. Recently, however, Air Force determined that this is not as effective as once thought.

Electro luminescence is the key to night lighting for the future, according to Zeller. Advantages of this form of lighting are that it produces no shadows, no reflections and has a good ratio of bright to dark.

Perhaps the most glamorous of directorate's six divisions is the Investigation and Field Operations Division. Functions of the I&FO Division are:

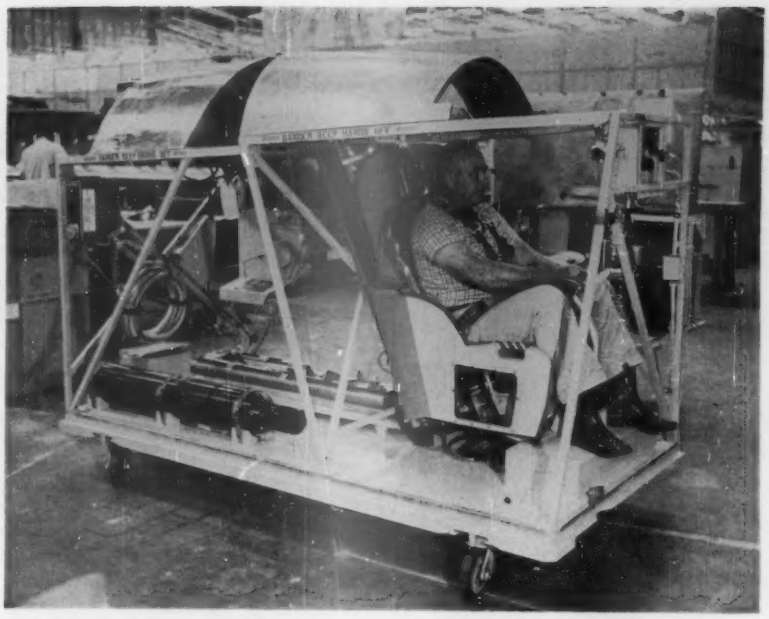
• **Aircraft accident investigation,** including on-site examination of aircraft accidents and surrounding circumstances. First-line combat aircraft, test and/or unusual aircraft are always investigated by a field team from DFMSR. More common administrative and training type aircraft are not of such immediate concern unless circumstances surrounding accidents or incidents are extraordinary. In the investigation of any accident, however, the commander of the base of the aircraft involved can request assistance from DFMSR. He may not, however, refuse cooperation if a field team from Norton decides to investigate. Field investigation teams in the capacity of inspectors general must be granted complete access to all information and final decision as to whether the accident is classified as major, minor, or as an incident rests with the flight safety directorate.

• **Operations safety surveys** also are conducted by teams from I&FO Division during which all facets of safety come under scrutiny. Included are communication and navigation facilities, refueling, and transient maintenance organizations, hazards to flight or aircraft ground operation, and trips to contractors and overhaul facilities.

• **Air crew indoctrination teams** also go into the field to assist in problems encountered during the transitioning to new equipment. Teams can draw on their experience with previous aircraft accidents and frequently can afford indoctrinating air crews the experience gathered while monitoring new equipment in test phase.

• **Weapon system survey teams** attend mockup boards and contractor technical compliance meetings on new systems while still in the development phase.

I&FO Division is divided into five branches: fighter, bomber, cargo, operations and facilities, and guided missiles branches.



Convair B-58 Ejection Seat Trainer

Mobile training unit for simulated ejections of pilot seat and canopy of the Convair B-58 Hustler jet bomber has been designed and built at Convair's Fort Worth, Tex., plant. Main purpose is to train pilots in exact location of ejection levers; when levers are activated, the seat rises about 6 in. and canopy moves back. Convair said the unit is the first of its kind to be used by the Air Force.

Pilot-Investigators

Considerable effort is expended, according to Col. F. L. Smith, to obtain highly qualified pilots for the three aircraft branches. Similarly, Operations and Facilities Branch and Guided Missiles Branch are staffed with the best available experience obtainable in their respective fields. Not only does this produce a staff qualified to assess aircraft accidents, but results in the investigating officers being able to talk to pilots and maintenance personnel with first-hand knowledge of the problem.

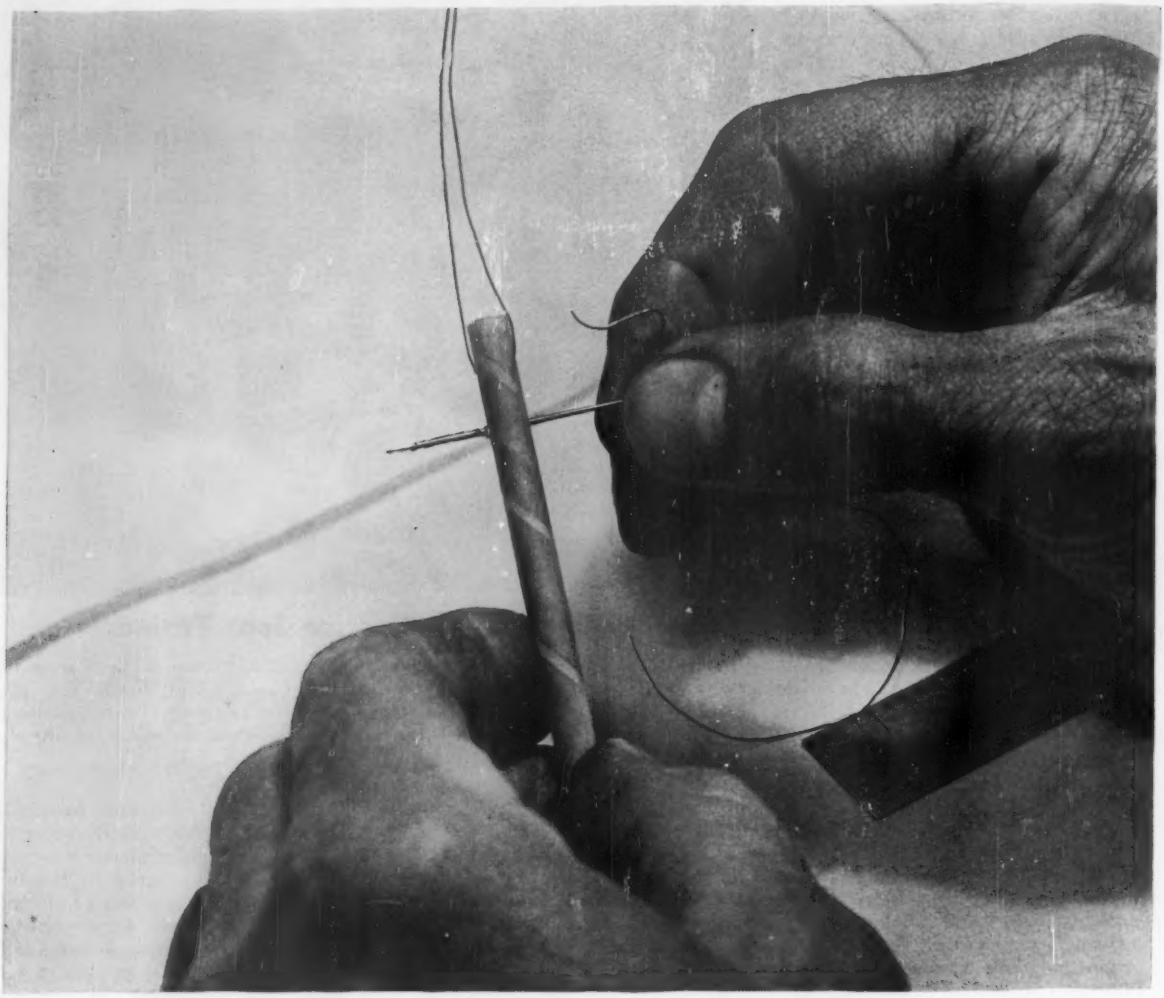
They are not always current in the assigned aircraft, but each branch has a man conversant with the operating procedures of the various aircraft. To this end, pilots assigned to the three aircraft branches go through indoctrination courses necessary for checkout. It has also been established that a working knowledge of the equipment is an asset when engaging in after-duty hangar flying sessions, a part of most field trips.

Final Evaluation

Research and Analysis Division, under Col. J. A. Herrington, makes the final evaluation of all aircraft accidents. Normally, changes are not made to the findings set forth by the home base investigating officer, but in some instances it is necessary, on the basis of incomplete or incorrect conclusions, to make changes.

R&A Division analyzes accidents and studies operations and maintenance procedures, recommending changes in one or both of these fields when this seems warranted. Examples of changes made as a result of operations analysis are the following:

• **Recommending ejection** from Century-series jet fighters instead of attempting flameout landings. Accident analyses showed that in many cases, pilots were setting up a flameout approach only to discover too late that they could not make the field. Attempted bailout in some cases was un-



How to Test a Solid Rocket Motor

In the early stages of research for new or improved propellants incongruous combinations of materials are often brought together in the chemistry laboratory—in this case, a common drinking straw, a strand of copper wire, a small batch of propellant and a sewing needle. The work shown here is a step in an experiment to test burning characteristics of a new high-energy propellant formula. The propellant, having been extruded into the straw, is threaded with a strand of copper wire. Later the "motor" is hooked into a specially designed apparatus that ignites the propellant and records and evaluates its performance.

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successful because the pilot had expended too much altitude in the dead stick landing attempt. This accounts in part for the increase in fatalities per accident while the accident rate has decreased.

• **Emergency landings** with landing gear extended mark a radical departure from previous practices wherein the landing gear was always retracted. Col. Herrington explains that this decision was brought about as the result of engineering research and analysis of emergency landings. Slower, conventional gear aircraft had a tendency to overturn if landed gear down on unprepared surfaces. However, Century-series fighters of higher density and a greater gross-weight-to-landing-gear strength ratio do not have this overturning tendency. Rather, extended landing gear absorbs a great deal of the initial shock as it is sheared off in initial contact. Abandoning the aircraft in flight, however, is still preferred over attempted emergency landing since the aircraft is generally destroyed and chance of survival is greater during ejection than in a crash landing.

Weak Link

Biggest single contributor to the Air Force accident rate, says Herrington, is the single engine fighter—weakest link in the aircraft system is the engine. He attributes this to operational requirements which dictate that nearly every mission profile must exploit the maximum performance envelope of the aircraft. DFMSR statistics indicate that complexity of the machine is not the prime problem, but rather the people who build, maintain and fly them.

He recommends increases in what he terms "compatibility engineering" or as Gen. Caldara put it, "total quality control." Herrington cites very few failures in the area of major structural or engine components. He said that wing failures or engine rotor shaft failures are rare indeed and that the main cause of accidents are little things. He suspects that aircraft companies concentrate on the big picture with less emphasis being placed on small details.

As an example he cites a magnetic chip detector which can be checked for continuity on the ground or wired into a caution light on the instrument panel has recently come into use. Chip detector becomes grounded if small metal particles, indicative of impending lubricated parts failure, cross its insulation. (Chip detectors are being pushed for installation in aircraft engine pumps, etc. Installed in several aircraft on a test basis, detectors are proving their worth.)

As an example of poor compatibility, however, Herrington cited one engine component failure which was caused when the chip detector's center electrode became free of its plastic insulation and caused a mechanical failure. Plastic had been designed for a certain maximum operating temperature but was used in this instance in an operating environment greater than that for which it was designed. He claims compatibility engineering could have prevented this occurrence.

One of the projects Herrington has pushed without too much success is the installation of time counters on engines, starters, and other accessories in aircraft. These could be similar in nature to the engine time counters found on most light aircraft tachometers. Air Force presently relies on pilots or mechanics to keep track of engine time or the number of cycles on a starter or other accessory. Frequently, these records are inadequate and result in components and/or engines being used beyond prescribed time or cycle period.

Air Force-Industry Conferences are the direct responsibility of the Programs and Administration Division. Conferences, started in 1954, have grown rapidly in attendance. The most recent conference in June, held in Los Angeles, was attended by representatives from 112 corporations. Discussions at the Air Force-Industry Conferences are naturally flight safety oriented,

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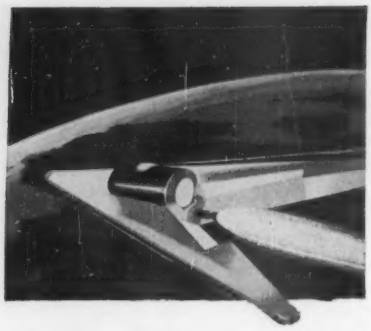

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and are unique from the standpoint that "dirty linen" is often aired by both sides. As with testimony given at accident investigation boards, matters brought up at Air Force-Industry Conferences are not for public consumption. Dual purpose is actually achieved by the conferences since Air Force and industry come to grips with each other's problems and, additionally, industry members benefit from discussions with each other.

Also arranged by the Programs and Administration Division are the annual world-wide USAF Flight Safety Conferences. A new twist is being given the next session to be held in Riverside, Calif., Sept. 14-18. The first day of the five day agenda will be open to unit commanders. DFMSR figures the commander is the most important key in flight safety and accident prevention. Commanders are welcome to remain for the ensuing four days, during which the various flying safety officers will be briefed on the latest in trends and procedures. Notices of attendance from commanders indicates that the September sessions will have a large attendance.

One example of a benefit to safety is the present retrofit program to apply rocket-assist to ejection seat catapults in Century-series fighters, a direct result of previous Air Force-Industry Conferences.

Other Duties

Additional functions of the Programs and Administration Division are the formulation and execution of administrative policy plus budget and personnel control for the 108 officers, 32 airmen and 130 civilians assigned to the Directorate of Flight and Missile Safety Research.

Safety Education Division, under Lt. Col. R. R. Springer, disseminates the information and statistics culled by the other divisions through three media—information and educational programs, flying safety publications, and public relations. Best known of the educational media is the University of Southern California Flying Safety Officers course, established in April, 1953. Currently, five classes per year of 25 students each, plus two classes of 25 foreign students each, attend the intensive courses at Pasadena. During the eight weeks course, students receive 260 hr. of classroom work devoted to aircraft accident investigation and accident prevention techniques. Safety Education Division is responsible for providing the subject matter used in the course of instruction.

Readership of one-half million has been established for the monthly Flying Safety magazine. A staff of seven, headed by Maj. F. D. Hessey, turns out the 46,000 monthly copies. Actually, about 41,000 are given to Air Force units and paid subscriptions account for 5,000 issues. Flying Safety is budget-limited to 384 pages per year, which may be divided to 12 issues as necessary. Biggest problem, Hessey says, is how to say the same old thing in a different manner. The staff's greatest amount of brainwork is directed toward telling pilots and ground crewmen what they should already know. Visual presentations are widely used in the magazine plus widely distributed cartoon posters, such as the Rex Riley series.

Major and minor accidents plus incidents involving aircraft, numbering 3,000 per year, are recorded by the Records and Statistics Division. Information from around the world is sent by teletype or other rapid communication within three hours after the mishap occurs. Within eight hours, a preliminary report must be submitted and final reports forwarded as expeditiously as possible. Incoming information is received by Records and Statistics Division, coded and then indexed as to type, i.e., major accident, minor accident, incident, whether materiel failure, inflight, etc. Quick reference files are made up on each incident or accident so that trends may be easily spotted. Narrative-type summaries are then prepared for inclusion in the next day's staff meeting.

Reports of aircraft accidents are maintained for four years in the extensive files here. Following this, they are microfilmed and kept for an additional 30 years. Records and statistics division is also the repository for all Air Force Form 5s, record of pilots' flying time.

Effective use is made of the vast amount of statistical data available at DFMSR to spot trends in aircraft accidents with an eye toward preventing them. Speed is essential in spotting trends and therefore daily staff meetings are held to review the previous day's accidents. Director of Flight and Missile Safety Research, or his deputy, presides over the daily meetings attended by all divisions of the directorate plus the liaison officers. Included among liaison personnel are representatives from major airframe and engine manufacturers who are permanently assigned by their companies in the interests of flying safety.

Mimeographed summaries of the previous day's aircraft mishaps are circulated throughout the directorate so that division representatives will have time prior to the staff meeting to assemble available data on the aircraft involved. Armed with this knowledge, division representatives are in a position to make immediate recommendations if a trend is indicated.

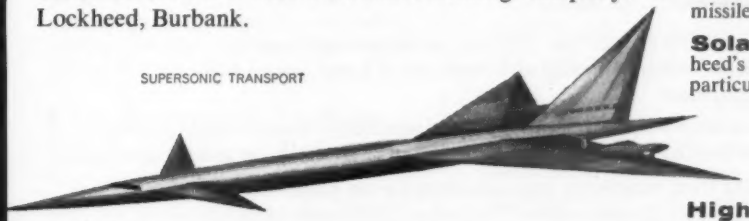
Examples of how the staff meeting helps to spot trends was revealed dur-

Space Transports *are under development now, capable of transporting a pilot and 1000 pounds of payload or three passengers—equipped to work in space—to an orbit of 1000 miles altitude. Indications are that an operational vehicle will be feasible and practical in the 1965 period.*

PROJECTS FOR FUTURE DECADES IN SPACE... *another Lockheed Progress Report to Engineers*

Plotting the nation's future space exploration projects requires the capabilities of a forward-looking company; one with vision, superiority in technical skills and advanced facilities. Lockheed, Burbank, long a leader in extending the science of flight, is placing its vast resources and accumulated knowledge into programs designed to provide major breakthroughs in the fields of: Basic and applied research; manned aircraft of advanced design; missiles and spacecraft. Shown here are artists' renderings of a few of these important projects. Such project diversification calls for high-level technical skill, offers genuine challenge to experienced engineers. At Lockheed these varied projects require engineers in many fields. Take advantage of this need. Go forward with a forward-looking company: Lockheed, Burbank.

SUPERSONIC TRANSPORT

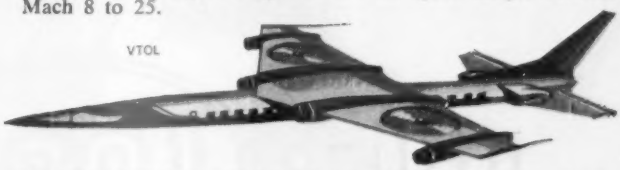


Supersonic Transports—have held an important place in our thinking for the past several years. Extensive wind tunnel tests have been conducted on many design concepts, supplemented by exhaustive laboratory and structure studies. Lockheed is prepared to build an airliner that will travel at speeds in excess of Mach 3 at an altitude of 75,000 feet.

Infrared Systems studies are being conducted using an advanced method of detecting fast-moving missiles and high-speed aircraft.

High Altitude Flight Vehicle programs have recently been awarded to Lockheed for supersonic vehicles of improved aerodynamic design configurations with speed ranges between Mach 8 to 25.

VTOL



Vertical Take-off and Landing Projects—Lockheed, Burbank, is engaged in exploring the potential of VTOL projects on a very broad scale. Different VTOL features are embodied in each proposal. Considerable emphasis is being placed on VTOL "air recovery" vehicles, designed for air rescue and reentry missiles recovery missions.

Solar Radiation Studies—are being conducted at Lockheed's flight test radio station at Briar Summit, California, placing particular emphasis on solar flares.

Manned Vehicle studies are being conducted concerning fundamental problems associated with landing manned vehicles capable of hypersonic glide or orbit above the earth.

High caliber scientists and engineers are invited to take advantage of Lockheed's outstanding career opportunities. Openings now exist in: *Aero-Thermodynamics; propulsion; armament; electronics—research and systems; instrumentation—wind tunnel; servomechanisms—flight controls; dynamic analysis methods; operations research; electrical instrumentation; physics; antenna; underwater sound propagation; and manufacturing research.* Write today to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept 11091, 2400 North Hollywood Way, Burbank, Calif.

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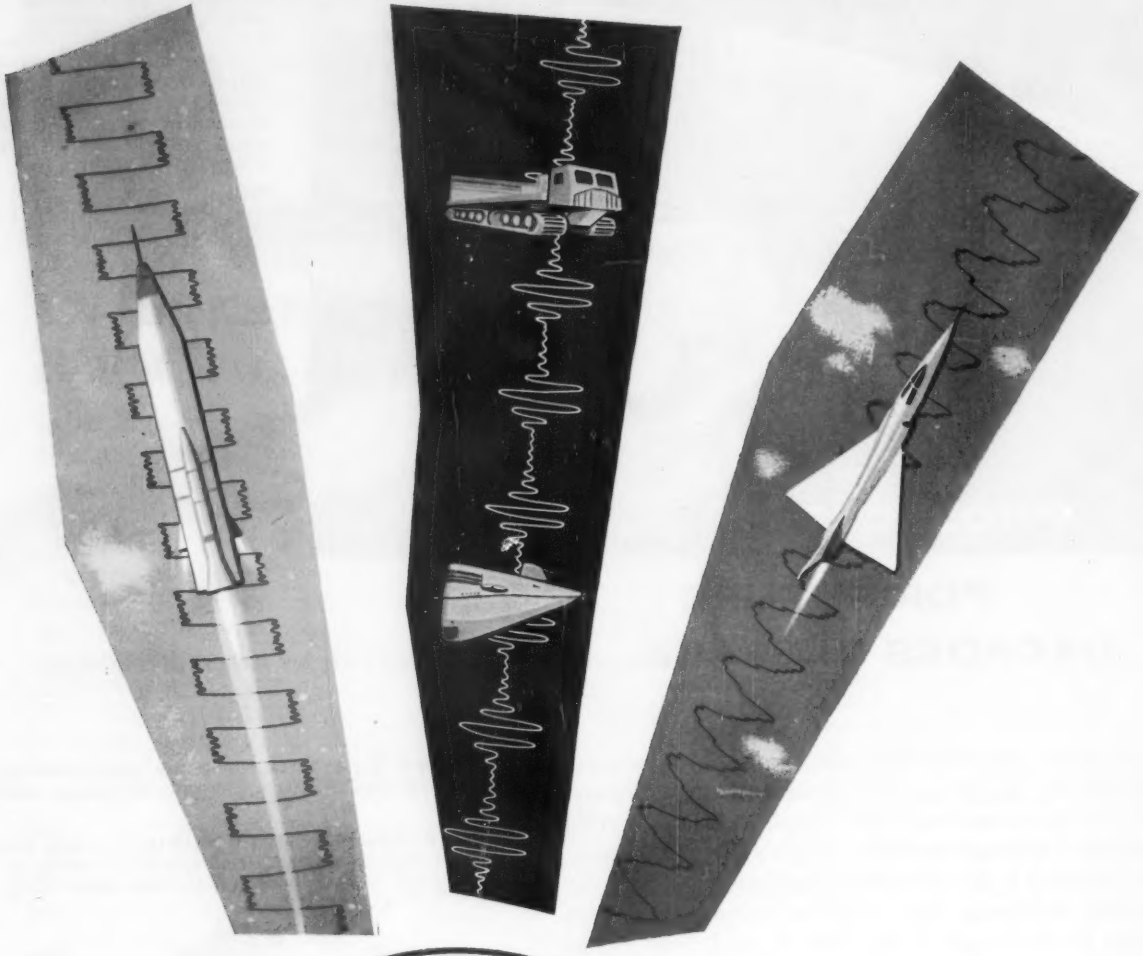

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"In Canada—Railway & Power Engineering Corporation Limited"

ing a recent rash of single engine trainer aircraft accidents. Each of the aircraft involved had been overhauled under Air Force contract. Investigation revealed evidence of laxity on the contractor's part in performing certain required maintenance. A flight safety team flew to the overhaul facility and pointed out the discrepancies to the contractor. This was sufficient to bring about a general tightening of overhaul procedures with a subsequent halt in the accident trend for that type aircraft.

Another example of trend spotting resulted from a recent flurry of accidents involving carburetor failures in a particular World War II type medium bomber. The project officer on this aircraft established that all the affected carburetors had been overhauled at one particular contract facility. Again, a flight safety team investigated and helped the contractor clear up the discrepancy.

Directorate of Flight and Missile Safety Research presently operates under Maj. Gen. Jack W. Wood, Deputy Air Force Inspector General for Inspection, but will soon be formally turned over to the office of the Deputy Inspector General for Safety.

Wood stressed to AVIATION WEEK that all information and testimony gathered in the course of an accident investigation is privileged information and cannot be used for punitive action, establishing liability, or as evidence in court action. He pointed out that the efforts of accident-investigating officers would be hamstrung if such information could later be used punitively.

This is particularly true in the cooperation of manufacturers' representatives who assist the director in his accident prevention program. Full-time representatives in residence at DFMSR are from Boeing, Convair, Douglas, General Electric, Lockheed, Martin, North American, Northrop, Republic and Pratt & Whitney. Information might be withheld from investigators on advice of legal counsel if such information could be used in subsequent punitive actions against either companies or individuals.

FAA Establishes Uniform Landing Control Point

Simplified landing clearances for aircraft on final approach are expected from FAA rule changes redesignating the former "airport boundary" reference to "approach end of the runway," establishing a uniform control point for all airports. Change also permits towers to grant landing clearance to traffic on final approach as long as other aircraft on the runway will be clear before inbound traffic passes approach end of runway.

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Rohr Interviews in October

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Akron	Chicago	New York
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Detailed resumes from qualified applicants will be held in confidence and given prompt attention in the arrangement of local interviews. Address J. L. Hobel, Industrial Relations Manager, AW-5, Rohr Aircraft Corporation, Chula Vista, California.

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. . . says C. D. Snelling, president, Standard Plastics, Inc.

"Our custom-molded urethane foam packaging saves our clients as much as 30% in costs, reduces bulk by one-third and weight by 75%," states Mr. Snelling.

"We proved to our customers that urethane foam has a definite place in the packaging field," he adds, "and 1959 is proving to be the big year in this developing industry.

"The excellent energy absorption of urethane foam at low density and low compression set is supplemented by the economy of this material in terms of cost, space and weight savings. For example, our foam package for magnetron tubes replaced a wooden packing case with rubberized hair at a cost saving of 30%, a cube space reduction of 85% and a weight saving of 65%. This means a reduction of 55 cubic feet per tube package and 157 pounds per unit—pretty important figures to a shipper!

"The no-dust feature of urethane foam is also very important in packaging sensitive instruments and components," says Mr. Snelling. "And the low moisture content (.3%) makes urethane foam virtually chemically inert as well as affording corrosion resistance to silvered surfaces and the like."

Standard Plastics, Inc., was formed in 1954 to mold urethane foam products exclusively. Recently a new 16,000 square foot plant was opened in Fogelsville, Pa., which, incidentally, has urethane foam-lined office interiors for temperature and sound insulation.

Write Mobay for other examples of how urethane foam specialists are working with industry to improve the profits and potential of new products.

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CAB Accident Investigation Report:

Maintenance Cited in Crash of DC-3

Shortly after noon Aug. 23, 1958, Frontier Airlines Flight 73 (Douglas DC-3) experienced an emergency gear-up landing two miles northwest of Pueblo, Colo., Memorial Airport and two minutes after its takeoff from runway 30 of that airport. Several of the 19 passengers and crew of 3 received minor bruises; there were no serious injuries. The aircraft was substantially damaged; fire did not occur. The weather was good.

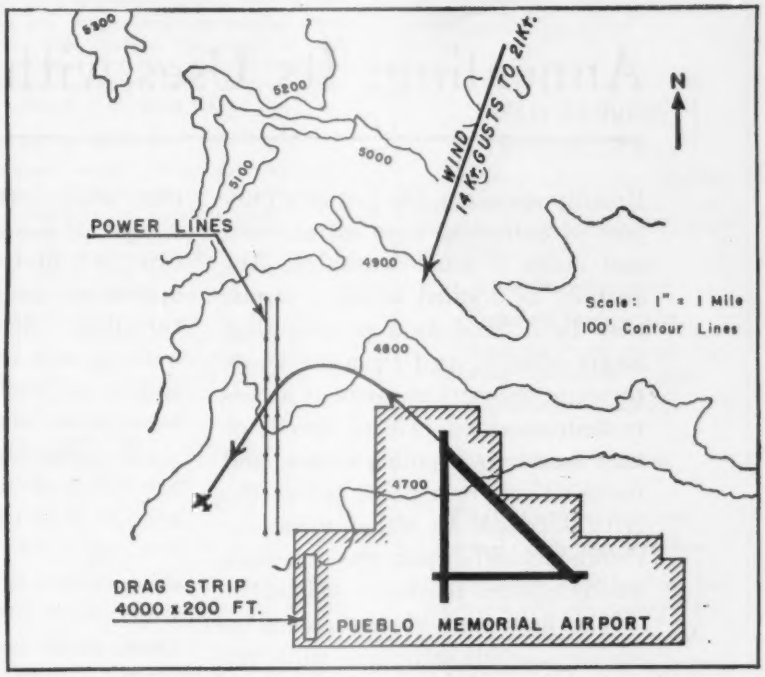
Flight 73 is scheduled daily, originating at Denver and terminating at Grand Junction, Colo. Intermediate stops are at Pueblo, Gunnison, and Montrose, Colo.

A normal takeoff was made from the Pueblo airport by the first officer in the left pilot seat. Immediately after the aircraft became airborne and gear retraction had started, the captain, in the right pilot seat, observed the cockpit fire warning for the left engine come on. In accordance with operations manual instructions, he immediately tested the fire-warning system but the warning light remained on; the captain then feathered the left propeller. The Pueblo control tower was advised that the flight was returning to the airport and the captain took over control.

Because of higher terrain ahead, a shallow left turn was made at an altitude of 50 to 75 ft. and at an indicated airspeed of 95 kt. This altitude and airspeed could not be maintained. After passing under a 34-ft. high power line with the airspeed dropping to 75 kt., the power was cut on the right engine. Ground contact occurred almost immediately and after a ground slide of nearly 1,000 ft. the aircraft came to rest on the underside of its fuselage.

There had been no fire in the left engine. A false fire warning had occurred because of a faulty electrical circuit. The carrier's maintenance procedures prescribed in its manual are adequate; however, in this instance a failure on the part of the maintenance department to find and remedy the defect precipitated the accident.

As a result of this accident the carrier is revising its operations manual instructions so that a pilot, when a cockpit engine-fire-warning signal occurs, may use his judgment and discretion about immediate feathering without a visual fire check.



FRONTIER pilot turned left after takeoff to avoid high ground shown on chart.

INVESTIGATION

Frontier Flight 73 originated at Stapleton field, Denver, departing at 1108[1] with 21 passengers. The crew consisted of Capt. James R. Langhofer, First Officer Donald L. Lockwood, and Stewardess Joanne V. Lohse. The flight to Pueblo was routine with arrival at 1145. Flight 73 departed Pueblo with 19 passengers and the same crew at 1204 on a VFR (visual flight rules) flight plan from runway 30. According to company load computation the aircraft was loaded to 24,420 lb., which is below the allowable takeoff weight of 24,900 lb. under the prevailing conditions; the weight was properly distributed with respect to the center of gravity.

According to aeronautically competent witnesses situated at the north of runway 30, the left propeller of N 64424 was seen to become completely feathered as the aircraft passed over them 50 ft. high at the end of the runway. They also observed complete retraction of the landing gear. The aircraft gained altitude very slowly on one engine, reaching approximately 100 ft. above the ground as it went straight out on the runway heading. A shallow left turn was started, followed by a gradual loss of altitude until contact with the ground was made. The witnesses were in agreement that no fire or smoke was observed while the aircraft was in flight or on the ground and that no parts or pieces were seen to fall during flight.

The emergency gear-up landing occurred at 1206 on unimproved ground two miles west-northwest of the Pueblo Memorial Airport. The ground elevation is 4,725 ft. Marks on the ground indicated the aircraft made contact on a heading of 190 deg. magnetic. The aircraft then skidded on the underside of its fuselage for a distance of 841 ft and passed over three shallow ditches or washes. At the third one the aircraft swung approximately 115 deg. to the right and the right engine was completely separated from its attachment at the firewall. One blade of the right propeller punctured the right side of the cockpit, severely damaging the right pilot seat and severing the CO_2 line thereby discharging the CO_2 bottle aft of the right seat.

Evacuation began immediately after the aircraft came to rest and was completed in approximately 1½ min. The first officer left through the front cargo door and proceeded to the main cabin door. The captain went through the cabin and opened the main cabin air stair door. All passengers except three deplaned through the main door without difficulty; these three passengers, acting on their own initiative, made their exit through the rear emergency window on the right side. At least one emergency inertia cabin light came on and remained on for nearly three hours.

Aircraft Examination

Examination of the aircraft revealed no evidence of failure or malfunction of the airframe or powerplants prior to ground impact. This is substantiated by the pilots who stated that there was no roughness or indicated engine malfunction during the takeoff. The warning light went out after the feathering and no CO_2 was discharged intentionally either in flight or on the ground.

Because of the circumstances related by the flight crew, immediate attention was directed to the fire-warning system. A review of pilot flight reports disclosed that N 64424 had experienced five false engine fire warnings between July 9, 1958, and Aug. 19, 1958. In each instance the left engine was involved and in no case was there a fire. The crew in this accident was not aware of the false fire-warning reports.

According to statements of the flight crew, the left propeller was feathered be-

[1] All times herein are Mountain Standard based on the 24-hr. clock; all altitudes are mean sea level unless otherwise stated.

XXIII

This is the twenty-third of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Annealing: Its Uses with Alloy Steels

Broadly speaking, the primary purpose of annealing is to soften steel and make it more workable. Annealing, as applied to alloy steels, may be defined as a process that heats above, and furnace-cools through, the critical range at a controlled, specified rate of speed; or that heats to a point within, and furnace-cools to a point below, the critical range. In either case, the choice depends upon the structure and maximum hardness desired.

The first method produces a lamellar pearlitic structure, while the second creates a spheroidized condition. These will be discussed separately in the following paragraphs:

(1) *Lamellar pearlitic structure.* It should be mentioned at once that this structure can be obtained both as described above and by a modified method known as isothermal annealing. In the isothermal process, the steel is heated above the critical temperature (austenitized), then transformed at a predetermined temperature, which depends upon the analysis. This operation requires two furnaces or salt baths —one for austenitizing, one for transformation.

Lamellar pearlitic structures are generally associated with machinability in carbon ranges from 0.20 to 0.60 pct, provided the hardness does not exceed the optimum maximum Brinell numeral. This is especially true where critical tooling is involved. It is a very versatile structure, as it gives best results in such operations as broaching, tapping, threading, deep drilling, boring, milling, and tooling as applied on single- and multiple-spindle bar automatic machines.

(2) *Spheroidized structure.* There are two general fields of use for this type of structure when alloy steels are employed. In the low and medium carbon ranges, spheroidization is necessary for cold-shaping operations, such as heading, extruding, drawing. In the higher carbon ranges (over 0.60 pct), it is mandatory where machining is involved, because it tends to lower the hardness of the steel.

As noted elsewhere in this discussion, both lamellar pearlitic and spheroidized structures can be created through annealing. If you care for more details about these and other uses of annealing, and the results to be expected, by all means consult with our technical staff. Bethlehem metallurgists will gladly help you work out any problems. And when you are ready for new supplies of alloy steels, Bethlehem can offer the full range of AISI standard grades, as well as special-analysis steels and all carbon grades.

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cause of the left engine fire warning appearing as gear retraction was started. A minute examination of the left powerplant failed to disclose any evidence of fire or of a hot spot that could have actuated the fire-warning signal.

The fire-warning system employed by Frontier Airlines on N 64424 consists of a series of thermocouples, any one or all of which when subjected to rapid heat rise will generate a very low voltage current which is sent through the circuit to a very sensitive relay in the relay panel. This sensitive relay closes at approximately four milliamps completing a circuit to a slave relay, thus closing it. When the slave relay closes, it connects the 24 v. circuit to the warning lamp circuit and lights the warning signal in the cockpit. The aircraft is equipped with a fire-warning thermal test unit on the cockpit instrument panel which tests the system for normal operation by switching in 28 v. to the system. As the element lights, the thermocouple is heated and creates a voltage, thus operating the circuit. Also incorporated is a switch called the fire panel "opposite" switch. This switch transfers the circuit system from one relay to another thereby providing a check for a false warning from a relay malfunction. In the present incident the "opposite" switch was actuated and the right warning light came on, which indicated absence of a fault in the left relay system and the probability of a fire.

Relay System

In order to energize the cockpit warning signal, the sensitive and slave relays must be activated. With both relays operating normally a minimum current of four milliamps must be introduced into the sensitive thermocouple circuits. The two ways of accomplishing this are: (1) an actual fire resulting in a rapid heat rise at a thermocouple; (2) current as little as four milliamps from an outside source such as leakage of current from a 28-v. line in the same bundle of wire containing the firewarning circuit as the result of frayed wire covering, dampness, chafed wire insulation, etc.

Subsequent to the accident, the relays and cockpit test switch were removed from the aircraft for examination. Each unit, plus the left engine thermocouples, was subjected to bench tests designed to test their integrity. The tests proved that all units were operating normally in accordance with specifications and that they were, in themselves, incapable of actuating a false fire warning.

Since there was actually no fire during flight, the circuits of the aircraft were carefully tested for continuity as well as possible leakage and/or short circuits between wires. All circuits in the fuselage, wing, nose, and associated junction boxes and instrument panels were found to be without electrical faults. Extending from the firewall junction box to the inboard nacelle junction box is a flexible conduit, approximately 40 in. long and three-fourths of an inch inside diameter, containing 15 tightly bundled wires. These wires included the sensitive thermocouple circuit wires as well as 28 v. circuits.

An ohmmeter indicated an irregularity in the thermocouple circuits. By moving one of the thermocouple wires in this conduit a variable resistance was present. Removal of the wires from the conduit disclosed a substance consisting of damp oxidized aluminum, oil, and dirt in the area of the conduit ferrule which connects to the junction box where bending and movement occurs. Two wires of the bundle were unnecessarily long and were found criss-crossing other wires. This condition was found to exist in the area where the electrical fault was found. Examination failed to disclose further indication of circuit faults.

Crossover Switch

Frontier Airlines' Policy and Procedures Manual, Flight Emergency Procedures section, stipulates that a captain, upon the first indication of engine fire-warning light in flight, will immediately check the warning light by switching the crossover switch to "opposite," as was done in this instance. If the transfer indicates "fire" he will call out the proper engine and immediately accomplish the single-engine checklist. The company's chief pilot confirmed that the emergency procedures in effect at the time of this accident did not call for a visual check of the engine prior to feathering.

The five previous false warnings occurred at different stations away from Denver and in various aircraft configurations. The pilot write-ups and their dispositions were as follows: (1) Found loose cannon plug at firewall. Tightened plug, checks OK; (2) checked system, no repairs recorded; (3) Repaired loose connection, system on left engine checks OK; (4) Checked system and found nothing wrong; (5) Changed fire-warning relay box complete. Pilot report copies were forwarded to the Denver base in each case but the base records do not indicate that corrective action was taken at the Denver base to eliminate the recurring false warnings.

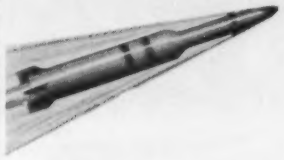
A special weather observation taken by the Pueblo Weather Bureau Airport Station at 1205 on Aug. 23, 1958, records the following conditions: measured 5,000 broken, 14,000 broken with higher broken; visibility 40 mi.; temperature 77; dewpoint 48; wind north-northeast 14 kt., gusts to 21 kt.; altimeter 30.14. Flight 73 had no choice of runways because of construction work at the airport. Company policy directs that the maximum cross-wing component is 22 kt. and that it will be based on reported gust velocities. In this case the cross-wind component was 20 kt.

The company training program included single-engine procedures in both original training and rechecks of their pilots. However, in practice emergencies a propeller feathering was simulated by reducing power to a no-thrust position. Testimony reflected that the company went beyond the usual requirements, one item being that all pilots receive three, rather than two, proficiency checks annually.

ANALYSIS

Reference to the company weight versus indicated airspeed chart for flight reveals that for a gross weight of 24,420 lb., the airspeed for best single-engine climb and maneuvering is 92 kt. The company manual minimum airspeed for single-engine is 84 kt. With an indicated 95 kt. following takeoff and the feathering of the left propeller, Capt. Langhofer had three knots above

ELECTRONICS: Over, on and under...



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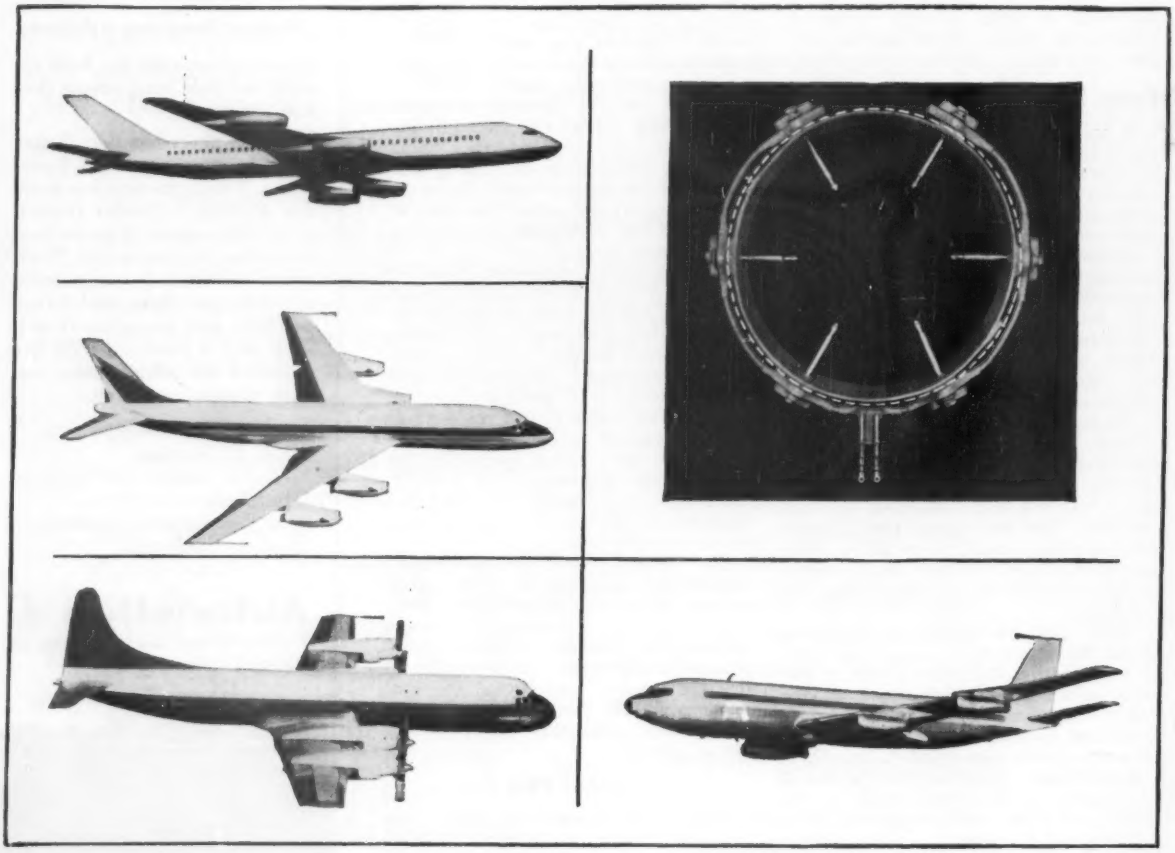

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the best single-engine speed for straight climb or maneuvering flight. According to competent witnesses, altitude was being gained very slowly as the aircraft left the airport boundary. The aircraft was then going toward higher terrain ahead and to its right.

Testimony was received regarding the effect of air-temperature upon rate of climb (reference-CAA Flight Engineering Report No. 12 issued under Safety Release No. 153). It was shown that with the gross weight of 24,420 lb. and the temperature of 75F, the aircraft should have been capable of a rate of climb of 282 fpm. on one engine. Even if it were possible to obtain this performance, the aircraft could not have cleared the high terrain lying ahead. Consequently, there was no alternative for the left turn away from the higher land. This turn, in conjunction with the loss of performance resulting from gustiness and turbulence caused by the high ground to windward, was a factor in the aircraft losing airspeed and altitude.

Glance Back

A glance back from the cockpit toward the left engine would have disclosed no evidence of fire and the action could have delayed the feathering of the propeller and averted the accident. However, the captain carried out emergency instructions as outlined in the company operations manual at that time. These instructions are currently being revised to give the captain an opportunity to use his own judgment regarding immediate feathering in the case of engine fire warnings.

Referring to maintenance practices it appears, in this instance, there was a definite failure to comply with the prescribed procedures in that the log office did not discover the recurring false fire warnings when they reviewed the pilot reports.

CONCLUSION

A study of the available evidence makes it obvious that regardless of the other circumstances of the accident, a false warning due to faulty wiring and/or the presence of foreign matter would not have occurred and triggered the events that followed had the maintenance department properly corrected the recent and recurring difficulties reflected in pilot write-ups of false fire warnings on this same engine and aircraft.

A few circuit tests would have revealed the electrical leakage and pointed out the need for replacement of the wires. The Board therefore concludes that the log sheets of the aircraft were not properly monitored; that corrective action taken by the maintenance personnel was not adequate; that there was a laxity on the part of the maintenance supervisory personnel in not detecting this inadequacy; and that the maintenance department was amiss in not progressing prompt and adequate corrective action as a result of the continued write-ups concerning the fire-warning system.

The Board determines that the probable cause of the accident was a false fire warning during climb-out toward rising terrain, followed by the immediate feathering of a propeller. The resulting aircraft performance under the existing conditions necessitated an off-airport landing. The false fire warning was due to inadequate maintenance.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti
Louis J. Hector

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of the accident the afternoon of Aug. 23, 1958. An investigation was immediately initiated in accordance with the provisions of Section 702(a) (2) of the Civil Aeronautics Act of 1938, as amended. Depositions, ordered by the Board, were taken at Kansas City, Mo., Oct. 20; Pueblo, Colo., Oct. 21; and Denver, Colo., Oct. 22-23, 1958.

Frontier Airlines, Inc., a Nevada corporation, is a scheduled air carrier with its principal offices at Denver, Colo. The company possesses a currently effective certificate of convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration (now Federal Aviation Agency) which authorize the carriage of persons, property, and mail over the route described in this report.

Capt. James R. Langhofer, age 32, was employed by Frontier Airlines May 5, 1950. He held a valid airman certificate with an airline transport rating and type rating for DC-3 aircraft. According to company records he had a total of 10,879 hr., of which 7,564 were acquired in DC-3 equipment. His last CAA (FAA) first-class physical examination was passed, no waivers or restric-

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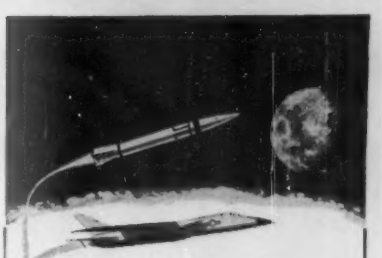

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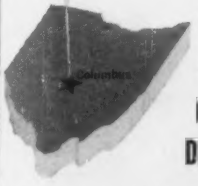

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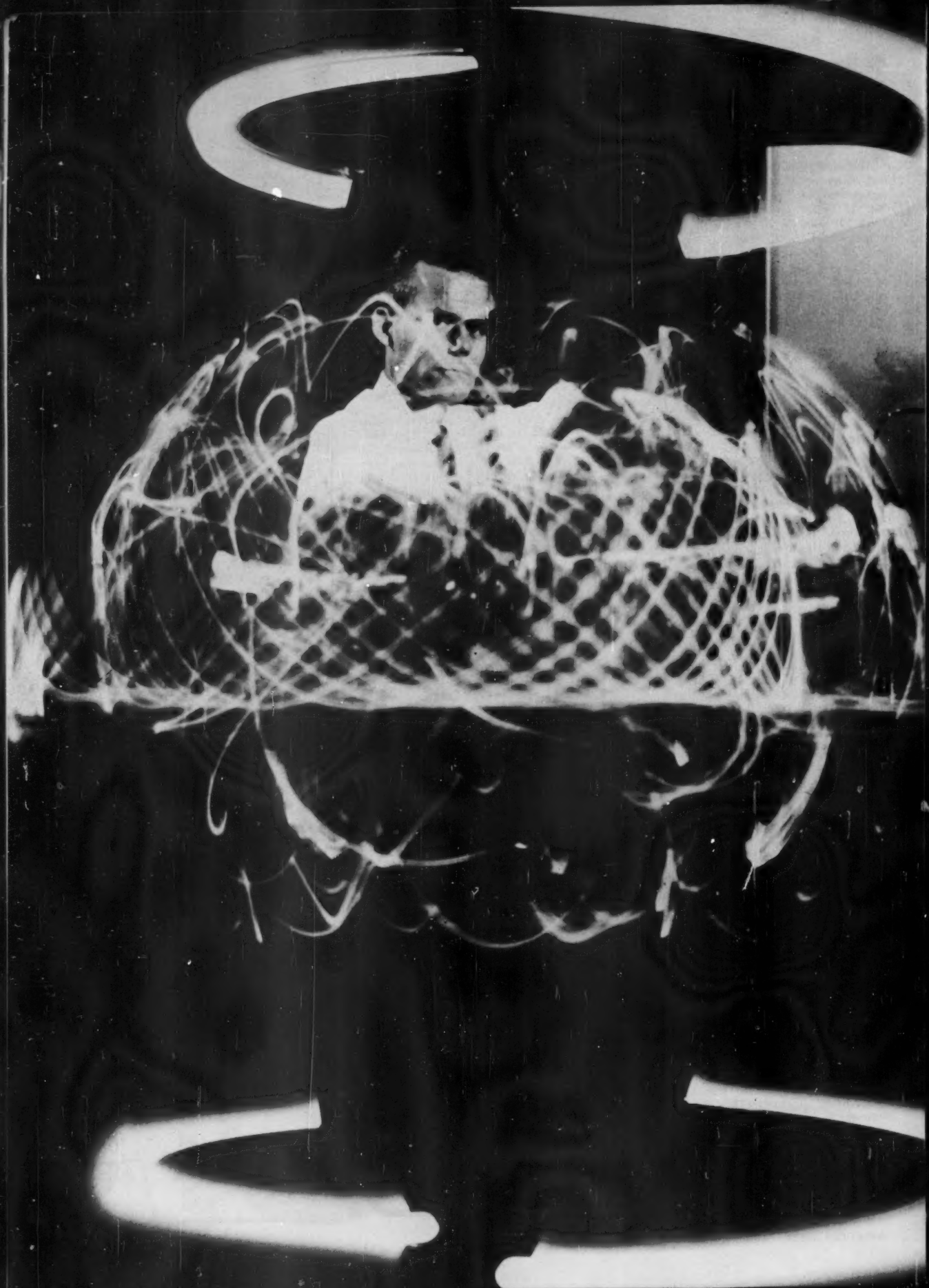

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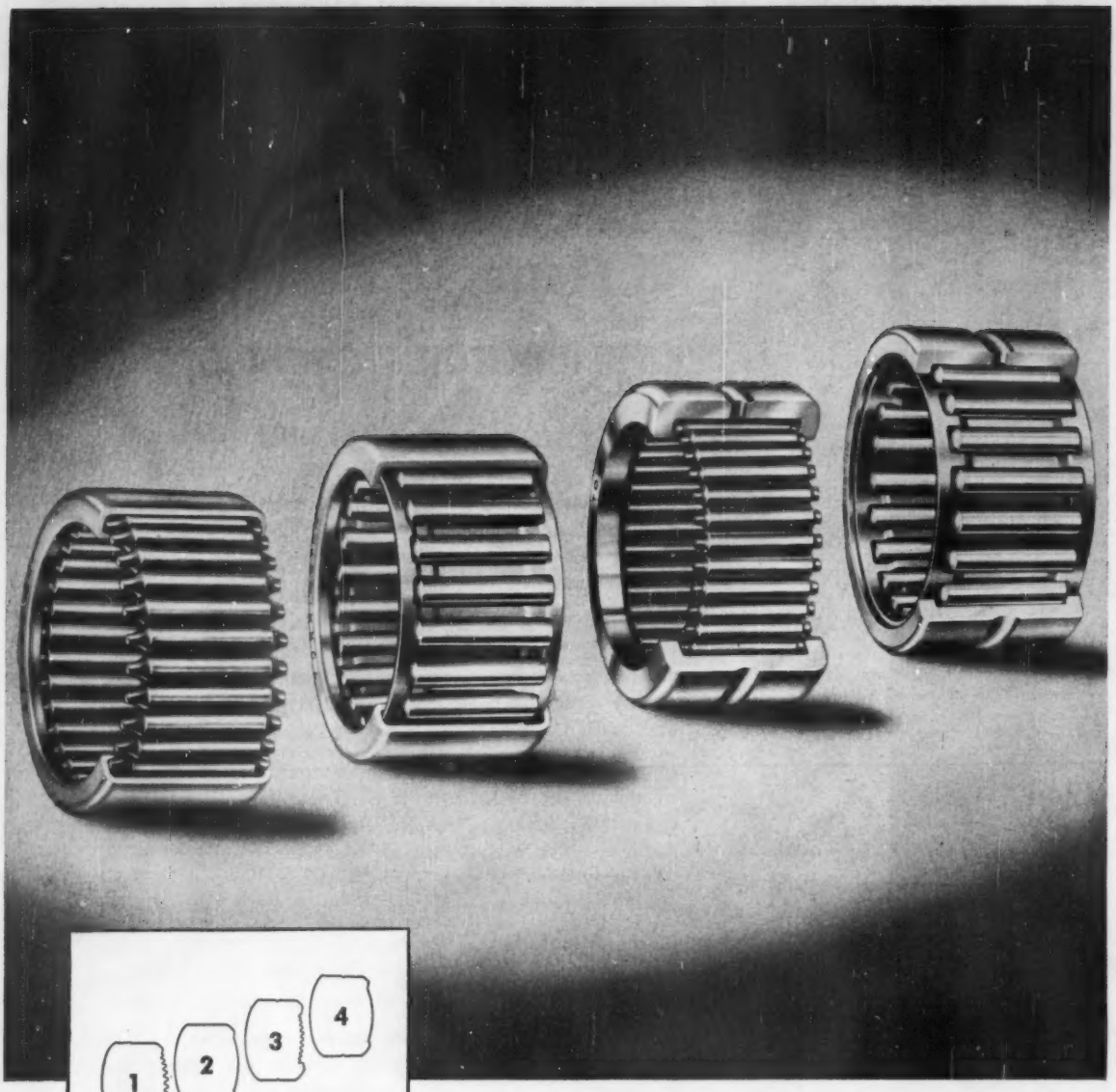

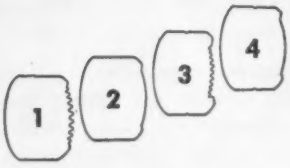

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tions, on Aug. 20, 1958. The date of his last line check was April 4, 1958, and his last instrument check was taken Dec. 5, 1957.

First Officer Donald L. Lockwood, age 25, was employed by Frontier Airlines Aug. 31, 1954. He held a valid airman certificate with commercial pilot and instrument ratings. According to company records he had a total of 910 pilot hours, of which 498 were acquired in DC-3 equipment. His last CAA (FAA) physical examination was passed on Dec. 13, 1957, with no waivers or restrictions. His last instrument check was on Dec. 27, 1957.

Stewardess Joanne V. Lohse, age 24, had been employed by the company since Feb. 2, 1955. Her training was completed Mar. 31, 1955.

The Aircraft

Douglas DC-3C, serial 4424, N 64424, was manufactured in June, 1942, and had a total flight time of 31,082 hr. The aircraft had 9,188 hr. since the last overhaul and 39 min. since the last No. 3 inspection. It was equipped with two Pratt & Whitney R-1830-92-SIC3G engines and two Hamilton Standard 23E50-473 propellers. The left and right engines had 794 and 847 hr., respectively, since the last overhaul. The propellers had 2,201 and 1,941 hr., respectively, since the last overhaul or reassembly This aircraft was approved under Type Certificate No. 669 with a maximum allowable weight of 25,346 lb., including de-icers. It was not approved under Note 12 for transport category operation.

Mobile Cooling Unit Designed for Pilots

Problem of heat inside air-tight full-pressure suits worn by pilots at Edwards AFB, Calif., where mid-summer temperatures reach 110 deg., has been solved by design of a refrigerated mobile dressing and pre-breather room to keep pilots cool prior to flights. Van was made for North American X-15 pilots, but is available to all pilots making high altitude flights.

To provide a livable temperature and workshop for waiting pilots, the mobile van was fitted with a 10-ton refrigerator unit, couches, oxygen supply, pressure suit test console, and a small workshop for maintenance. In addition, there is a radio connection with the X-15 control van so the pilot can listen to preparation progress.

The van serves as a dressing room for the pilot and then while he receives his pre-breather of 100% oxygen (a basic requirement for high altitude flights), he receives pre-briefings and consultations with engineers. At the same time, his suit is checked for performance.

The unit was deemed necessary to survival in the desert heat since body temperatures inside the aluminized MC-2 suits rise to "unbearable degrees." On a recent flight of 1½ hr., a pilot lost 7½ lb. and a quart of perspiration was poured from the pressure suit on his return. Lowered efficiency and increased danger of accidents could result from such a body temperature rise.

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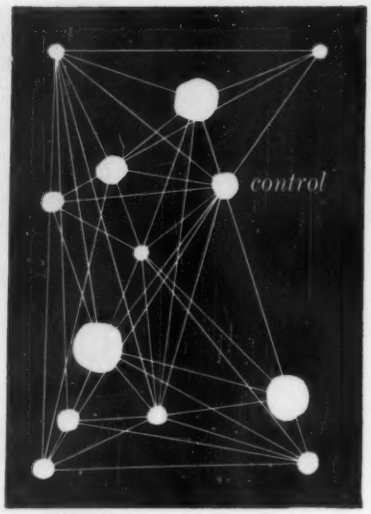

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LETTERS

Sodium Cloud

Your article on the recent sodium cloud rocket (AW Aug. 24, p. 27) omits what we consider to be a very important point. That point is that the preparation of the payload, the photographic coverage of the cloud from the five different sites, and the reduction of the photographic measurements to wind velocity and wind diffusion information are all responsibilities of Geophysics Corporation of America which is operating under a NASA contract.

RICHARD D. COONS
Director of Contracts
Geophysics Corporation of America
Boston, Mass.

Jet Transition

Having just taken the trouble to file a dissenting opinion in response to FAA's call for comments on the proposed rule that would prevent airline pilots over 55 from checking out in jets, I find it difficult to absorb any dogmatic assertions like that in the unsigned letter from the Los Angeles airline pilot (AW Aug. 10, p. 134).

He asserts, "Any airline pilot knows the deterioration in efficiency and reflexes which develop when a pilot passes 50, and certainly no pilot over 55 has any business flying high performance jet airliners."

The statement could apply in some cases, but may I say mildly that it should be subject to proof in all its sweeping connotation? Anyway, I doubt if many of the older, even famous name pilots of aviation's various branches, including airlines, will now stop flying jets because of the assertion from out L. A. way.

It is indeed unfortunate that some airlines' jet training programs got off to false starts. It would seem that many of the older pilots, being first up, had to bear the brunt of the training programs' growing pains. But cheer up, I hear that things are getting better.

It was to be expected that pilots who had been flying one type of equipment day in and year out, in a manner prescribed by their employers to the last detail, would have a bit of trouble ungrooving some of those little habits that would not apply to those ever so hard to fly jets. What was not expected were some of the gross inadequacies and "cowboy and Indians" early approaches to the whole subject of jet transition that were reported in the early stages of the transition programs.

The handicap of experience is perhaps illustrated by a paragraph in AVIATION WEEK (July 6, p. 63) which referred to the adaptability of pilots to the new integrated instrument panel. Your author said, "Transition time from a standard panel to the advanced instrument panel varies according to pilot experience, usually taking longer with more experienced pilots, less with the inexperienced men." Now I wonder how brilliantly the L. A. airline pilot would do in the matter of his own instrument flight reflexes if he were suddenly to find himself a transition student on the new military integrated instrument panel?

The question is not intended as a curve, but as a reminder that good pilots can sometimes find themselves on the other side of the fence. And besides, all of AVIATION WEEK's back page correspondents should try to get along and try to fathom out a business where there are more myths per minute than rpm's. Like for instance—that it's such a great big difficult thing for an adequately trained pilot to safely fly one of them thar jet airliners.

ROBERT E. TRIMBLE
Washington, D. C.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Crew Controversy

I would like to challenge at least two points made by "Airline Pilot" (AW Aug. 10, p. 134). First of all I would say that I would not want my signature at the bottom of such a letter, either, so I hardly blame him for requesting that his name be withheld.

Point number one: I fail to see how "Airline Pilot" can make such a statement as, ". . . Gen. Quesada has instead chosen to engage in querulous debates with the president of the Air Line Pilots Assn. . ." As everyone knows, Mr. Sayen of ALPA made public his letter to Gen. Quesada in which he made wild and unfounded accusations of ". . . childish Gestapo program . . ." used by Gen. Quesada and his agents. Gen. Quesada's reply was hardly querulous but clear and to the point, in telling Mr. Sayen that upon presentation of evidence he would take steps to eliminate such program.

Point number two: "Airline Pilot" states flatly that FAA has failed because, among other reasons, it failed to "settle the still smouldering pilot-flight engineer controversy by specifying that the third man on the jet be pilot-qualified." In typical ALPA fashion, this man is screaming failure, incompetence, etc., simply because FAA has not immediately ruled in favor of his faction. The U. S. Air Force has been operating, for several years, multi-jet aircraft with only two pilots, and under far less favorable conditions than any airline—but this is neither here nor there. Mr. "Airline Pilot" is probably so thoroughly brainwashed by the ALPA line of "we are the Supreme Beings" on the airways, FAA and other agencies should accept recommendations unquestionably, that we can hardly place blame on him for his opinions.

1ST LT. WILLIAM E. PRATT, JR.
48th Air Rescue Squadron
Eglin AFB, Fla.

Selecting Heads

People who will not put signatures to their editorial assists, such as "Airline Pilot," Los Angeles, Calif. (AW Aug. 10, p. 134), completely nullify their efforts in attempting to reach others. However, if the figures put forth by ALPA (AW Aug. 3, p. 37) anent the ages in the 27 commercial air crashes laid to pilot error from 1946 to 1959 (and one must consider them official since they are in confirmed government records), then this same nameless person can cut down his verbiage.

But let's go a bit farther in this latest government hassle anent retirement of pilots, etc.

If ever there was a branch of technicians, mistakes and errors considered, as highly trained and constantly checked as the airline pilots—where are they? Here is a group that is usually allowed one mistake, and that one either kills them or fires them. Now let's look at the government who will control us.

Look at its record. They need a head of CAA or FAA, if you will, and in goes a fighter pilot, military man, when there are thousands of men who have been in the air transport industry for 30 years and more who would have been better qualified.

Then we needed someone to head a space agency, so we didn't get von Braun who put our first successful one into space; no, we got a college prof from New England. Then we needed a Secretary of Defense one time, and we got a boy wonder from industry named Wilson who balled us all up when there were qualified military men who should have been considered for a defense position, it figures.

I'm not saying Sayen is the man to do it, that's up to his membership, but I will say that when the governmental agency which controls these same technical people they would retire unilaterally with no basis of fact, has and maintains equal efficiency and proficiency and some logic in their pick of heads of various controlling agencies, I might listen to Washington.

W. C. HELLER
Flourtown, Pa.

News Freedom

I want to thank Mr. Jack Caldwell (AW June 8, p. 122) for saying better than I can the feeling many of us have about over-eager commercial news gatherers. Certainly the supposition that because a classified project is momentarily exposed to a local resident, Russia also has the word, is nonsense.

A free press—meaning freedom to print the news so that it sells the most newspapers—is something most of us prefer to a censored press.

But I, for one, would be happy to lock the cell door on reporters who use telephoto lenses to get Titan pictures or fly over the Douglas plant for a missile shot.

ALAN POPE
Albuquerque, N. M

advanced

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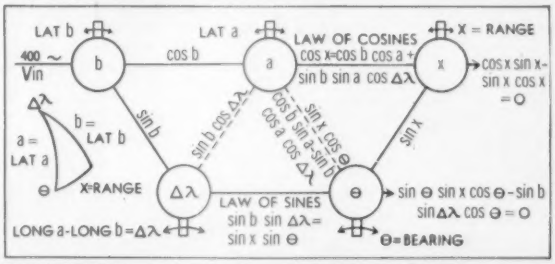
SIZE 8 FEEDBACK WINDING RESOLVERS

These resolvers are designed for use with transistorized amplifiers and permit the solution of spherical triangles in a size 8 cascaded resolver chain.

Functions of the spherical triangle which can be produced are indicated in the schematic below. More complex trigonometric functions, as well as systems involving coordinate axis transformation, can be generated with the use of these resolvers.

Accuracy: Functional error .1% or less; winding perp. ±5′. Electrical characteristics: Input voltage 15v400~ (stator); output voltage 13.7v (rotor); phase shift (stator as primary) 20.5°; output voltage 13.7v (compensator); Zro 234 + j596; Zso 244 + j548; Zcompensator 237 + j553; max. null voltage 1 mv/v.

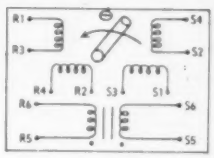


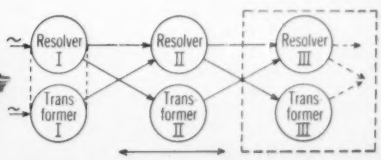
SIZE 11 AMPLIFIERLESS RESOLVER FOR ANGULAR DATA TRANSMISSION

These size 11 resolvers incorporate an integral transformer which simulates a resolver function at maximum coupling. They are used in the typical chain application indicated below for angular data transmission. In this particular application, the output information can be servoed at either end of the chain.

Quick disconnect allows ease in harnessing.

Accuracy: ±5′ of arc or less; winding perp. ±5′. Electrical characteristics: Input to EITHER rotor or stator. Input voltage 115v1600~; output voltage 110v both stator and rotor as primary; phase shift (stator primary) 1.1°; phase shift (rotor primary) 1.9°; Zso (nom.) 990 + j13500; Zro (nom.) 1150 + j13500.





SIZE 11 RESOLVER TRIMMED FOR ZERO PHASE SHIFT CONTAINS ALL COMPENSATION IN 2¼″ LENGTH

The YZC-11-E-1 precision computing resolver has been developed for use in a cascaded, amplifierless resolver system at 900~.

These units have been trimmed to provide zero phase shift and compensated for transformation ratio stability, under temperature, when working into their iterative impedance.

Accuracy: Functional error .1% or less; winding perp. ±5′. Electrical characteristics: Input voltage (stator) 40v900~; output voltage (rotor) 33.2v; phase shift 0; max. null voltage 1 mv/v.

Also ready for delivery is an equivalent, compatible pancake resolver. By its use, differential information from an inertial platform may be obtained and introduced into the system.

ENGINEERS—Join the leader in the rotating components field. Write David D. Brown, Director of Personnel, Dept. A9

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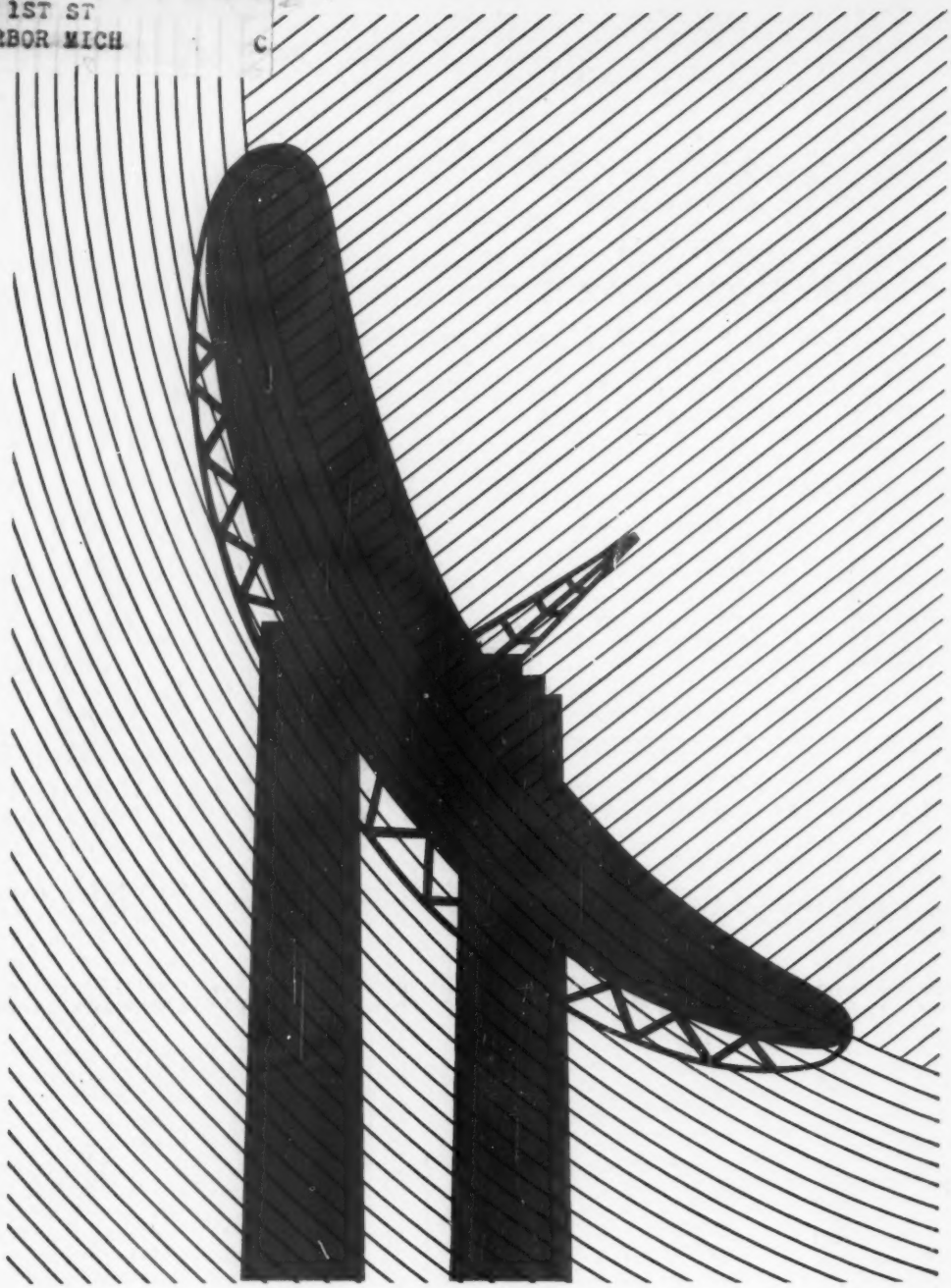

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